Jane's

STRATEGIC WEAPON SYSTEMS

Edited by Duncan Lennox

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Jane's Information Group Inc, 1340 Braddock Place, Suite 300, Alexandria, Virginia 22314-1657, USA

Copyright enquiries
Contact: Keith Faulkner, Tel/Fax: +44 (0) 1342 305032, e-mail: keith.faulkner@janes.co.uk

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Front cover image: *AS-18 'Kazoo (KH-59M)* ***under*** *wing of Su-30MK* **aircraft** **2002**/0533746

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DEFENSIVE WEAPONS

ARMS CONTROL TREATIES

WEAPON INVENTORIES

OFFENSIVE WEAPONS – OBSOLETE SYSTEMS

DEFENSIVE WEAPONS – OBSOLETE SYSTEMS

How to use *Jane's Strategic Weapon Systems*

Jane's Strategic Weapon Systems has been constructed around seven main sections, entitled Offensive Weapons, Defensive Weapons, Arms Control Treaties, Weapon Inventories, Obsolete Weapons, Prime Contractors' Addresses and Alphabetical Index. This publication has been designed to present the known facts about weapon systems and treaties within a broad definition of the term 'Strategic', in a single cover and in a format for easy reference. Some of the information is published in other Jane's yearbooks, but a standard format has been adopted in *Jane's Strategic Weapon Systems.* In preparing each edition the Editor has had to selectively assess the sometimes conflicting available information, and at times fresh interpretations have been made. However, the aim throughout has been to provide the user with an impartial assessment, and to try to provide further information in those areas where there are few details available at the present time.

At the beginning there is a Contents section, which lists each weapon system in order by country of origin and each treaty in order by date of signature; this is the order in which the entries are presented. The Contents pages have the page numbers for each entry. In the last section there is an Alphabetical Index where all the entries are listed in order, and some entries are listed twice. The entries are ordered by the first letter of the designator, and the first letter of the name. For example, the RGM-109 Tomahawk is listed as RGM-IO9 Tomahawk and as Tomahawk RGM-109. The Alphabetical Index has page numbers beside each entry.

At the beginning of both the Offensive and Defensive Weapons sections there is an Unclassified Projects section, which details what is known about weapons that may be in development or in service, but for which we have insufficient information to make a complete entry. In addition, following the Unclassified Projects in the Offensive Weapons section, there are some details of satellite launch vehicles. These have been included as some nations have maintained close connections between ballistic missile and satellite launch vehicle programmes, as they share so many common technologies. The Offensive Weapons section contains systems with the capability of carrying nuclear, biological or chemical warheads of mass destruction, although it is known that some have not been fitted or tested with such warheads to date. This section contains entries for ballistic missiles, cruise missiles, surface-to-surface missiles, air-to-surface missiles and nuclear bombs. The Defensive Weapons section contains entries that are Anti-Ballistic Missile (ABM) systems. designed to intercept the re-entry vehicles of intercontinental ballistic missiles, with a range exceeding 5,500 km. This section also contains defensive systems designed for use against theatre systems, that is short-range and intermediate range ballistic missiles, cruise missiles, surface-to-surface missiles, air-to-surface missiles, aircraft or Unmanned Aerial Vehicles/Remotely Piloted Vehicles (UAV/RPV). The theatre defensive systems may be land- or sea-based. In addition, this section includes anti-satellite systems.

The Offensive Weapons and Defensive Weapons sections' entries are written in a standard format, each entry having six main paragraphs entitled Type, Development, Description, Operational status, Specifications and Contractors. Type includes a brief one line description of the weapon system, indicating the range and use. Development includes the timescales for the weapon research and development phases, the different marks or versions developed and the carrier platforms. Description explains the major operating modes of the weapon system, as well as the size of the weapon, guidance and control methods used and the propulsion system. Operational status discusses the development and in-service phases of the system, numbers of missiles in service, flight testing programmes, and details the countries operating each system. Specifications lists the major parameters of each system, for easy reference. Contractors mentions the prime contractors, second source lead company or the design bureau for each system. In addition to these standardised entries, there are photographs or diagrams of the weapon systems whenever these are available. Some pictures are followed by a seven-digit number for ease of identification by *Jane's* image library.

Most of the information provided in *Jane's Strategic Weapon Systems* comes from the governments or manufacturers concerned, but this has not always been available. In certain instances, therefore, we have made interpretations on specific weapon capabilities that reflect a different appraisal of the available information and evidence, looking at the likelihood and realism of particular technologies and capabilities rather than accepting what has been provided. Above all, we have tried to be objective and impartial and when we do not know certain facts we have said so.

There are a number of terms whose meaning needs defining, the most important of which are 'strategic', 'range', 'defensive' and 'offensive'. Strictly, the "ability to strike at the heart of a nation at will" is a definition of 'strategic'that is independent of the range of the missiles themselves. This is accepted by most nations for their ship-/submarine-based forces. It is also the definition that has been applied, particularly by the Russian Federation, to land-based forces. For example, the Russian Federation viewed the European-based USA missiles, such as the Pershing and ground-based cruise missiles, as strategic, as did the USA for the Russian ballistic missiles placed in Cuba in 1962. Clearly, however, such a generalised definition of 'strategic' is unsatisfactory for treaty negotiation purposes as it would be both inadequate and 'catch all'. Hence, it has sometimes been defined in the treaty forum as a numerical range requirement of at least 5.500 km. this being the minimum separation between the USA and the Russian Federation in the direction across the Atlantic Ocean. Both of the negotiating powers applied this range requirement to their land-based missiles whilst classifying all ship-/submarine-based forces as strategic, irrespective of their range. The START agreements of 1991 added a further definition for cruise missiles, defining those with a range in excess of 600 km when air-launched as strategic weapons. Unfortunately, there is no clear definition of a cruise missile, and popular usage has adopted the term as applicable to air-to-surface and surface-to-surface missiles with a range in excess of 50 km.

The definition of range has long been one of the most contentious issues about weapons. Most manufacturers are extremely sensitive to the figures quoted. With land-launched air-breathing systems, the ranges generally represent the maximum kinematic range achievable without headwinds. For sea-launched systems they generally represent stationary surface launch and not submerged launch ranges, and for air-launched systems the quoted ranges are generally for launch at high altitude. Thus, in each case the best range figures considered to be achievable under favourable conditions are those claimed. Offensive ballistic weapon systems with ranges below 5,500 km fall into either the 'intermediate range' category, with ranges of 500 km to 5,500 km, or the 'shorter range' category, with ranges below 500 km. Significantly, however, the 1987 INF agreement introduced changes in the definition of the 'range' of missiles in these sub-strategic groups. Until this treaty came into force, 'range' meant the computed maximum possible range of a missile, but it has now been redefined as the operational range, or the maximum range flown in trials. This produces range values that are about two thirds of the maximum computed range. For treaty negotiation purposes this change was both necessary and welcome, for it eliminated the disputes that surrounded the maximum range calculations.

The division of defence assets into 'Offensive' and 'Defensive' categories is not without inconsistency. Some systems, such as anti-satellite weapons, are currently regarded as defensive weapons. A reasonable proportion of the world's satellites is used either directly or indirectly for military purposes, and hence in war might be attacked. This could result in anti-satellite weapons being regarded as offensive weapons, but for the time being ASAT systems are classified as Defensive Weapons.

At the beginning of the Arms Control Treaties section there are some outline notes on each treaty, giving a brief history and status, and also the key treaty provisions. This is followed with each of the relevant arms control treaties with the complete text of the agreement, as well as protocols and agreed statements supporting the treaties.

The Weapon Inventories/Obsolete Weapons section contains tables of offensive and defensive weapons, inventories listing the weapons held by each country in the world and a historic section with entries describing obsolete ballistic and cruise missile systems and obsolete ABM systems. The tables of offensive and defensive weapons give key performance details of each weapon listed for ground-, sea- or air-launched systems, further divided to separate ballistic missiles from surface-to-surface, air-to-surface

and cruise missiles. **In** addition, the defensive weapon tables separate theatre defence weapons from anti-satellite and anti-ballistic missiles. The country inventories list the types of offensive and defensive missiles either in service or in research and development in each country. The obsolete section only contains missiles that entered service, and does not include weapons that were cancelled in development. The purpose of retaining data on obsolete missiles is twofold; to assist military historians and to assist analysis of new missiles by comparison with earlier examples. The Prime Contractors' Addresses section contains addresses and telephone numbers listed in country order, and this is followed by the Alphabetical Index.

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Duncan Lennox
The Editor
Jane's Strategic Weapons Systems
Jane's Information Group
Sentinel House
163 Brighton Road
Coulsdon
Surrey CR5 2YH
United Kingdom

Duncan Lennox

Duncan Lennox served for 32 years in the Royal Air Force. He was an engineer who qualified as a pilot, and specialised in guided weapons procurement. He set up his own consultancy business in 1987, and has worked in the field of ballistic and cruise missile defence ever since. He has been the editor of *Jane's Strategic Weapon Systems* since it was first published in 1989, and writes regularly for *Jane's* on missile subjects. He has presented on evolving missile capabilities at many international conferences, and has given TV and radio interviews.

Glossary

ABL	armoured box launcher or airborne laser
ABM	anti-ballistic missile
ABT	air-breathing threats
ACTD	advanced concept technology demonstration (USA)
AD	air defence
ADATS	air defence anti-tank system
ADKEM	Advanced kinetic energy missile
ADAAM	air directed air-to-air missile
ADSAM	air directed surface-to-air missile
AEW	airborne early warning
AFB	air force base
AGM	air-to-ground missile designator (USA)
AIM	air intercept missile designator (USA)
ALCC	airborne launch control centre
ALCM	air-launched cruise missile
ALERT	attack and launch early reporting to theatre
AOC	air operations centre
APAM	anti-personnel/anti-material
API	ascent phase intercept
ARM	anti-radar missile
AS	Russian air-to-surface missile designator (NATO)
ASAT	anti-satellite weapon
ASM	air-to-surface missile
ASMP	air-sol moyenne portee (air-tosurface medium-range) (France)
ASROC	anti-submarine rocket
ASW	anti-submarine warfare or weapon
ATACMS	army tactical missile system
ATBM	anti-tactical ballistic missile
ATL	Airborne tactical laser
ATM	anti-tactical missile
AWACS	Airborne warning and control system
BCP	Battery command post
BGM	Multiple launch environment surface attack missile designator (USA)
BITE	built-in test equipment
BM	Ballistic missile
BMC^3	battle management command control and communications
BMD	Ballistic missile defence
BMDO	Ballistic Missile Defense Organization (USA)
BMEWS	Ballistic missile early warning system
BPDMS	basic point defence missile system
BPI	Boost phase interceptor
BW	Biological warfare
CAD	close in air defence
CBW	Chemical and biological weapons
CCD	Charge coupled diode (tv camera)
CCM	Conventional cruise missile
CEP	Circular error of probability
CG	Guided missile cruiser
CIWS	close in weapon system
CLOS	Command to line of sight
CLS	Capsule launch system
CM	Cruise missile or countermeasures
CMD	Cruise missile defence
CMT	Cadmium mercury telluride
COIL	Chemical oxygen iodine laser
CONUS	Continental United States
CSA-N	Chinese surface-to-air missile (navy) designator (NATO)
CSS	Chinese surface-to-surface missile designator (NATO)
CSS-N	Chinese surface-to-surface (navy) missile designator (NATO)
CTBT	Comprehensive Test Ban Treaty
CV	Aircraft carrier
CW	Continuous wave or chemical warfare
CWC	Chemical Weapons Convention
CZ	Chinese space launch vehicle designator
DACS	Divert and axial control system
DDG	Guided missile destroyer
DEW	Directed energy weapons
DF	Dong Feng (East Wind – Chinese ballistic missile designator)
DoD	Department of Defense (USA)
DOT	Designating optical tracker
DRDL	Defence Research and Development Laboratories (India)
DSMAC	Digital scene matching area correlation
DSP	Defense support programme (USA early warning satellite system)
DST	Defence and Space Talks
ECCM	Electronic countercountermeasures
ECM	Electronic countermeasures
EFOG-M	Enhanced fibre optic guided missile
EKV	Exoatmospheric kill vehicle
EMD	Engineering and manufacturing development
EMG	Electromagnetic gun
EMI	Electromagnetic interference
EML	Electromagnetic launcher
EMP	Electromagnetic pulse
EO	Electro-optical
EOS	Electro-optical sensor
ERINT	Extended range interceptor (PAC-3)
ESM	Electronic support measures
ESSM	Evolved Sea Sparrow missile
ETC	Electrothermal-chemical
EW	early warning
EWR	early warning radar
FAAD	Forward area air defence
FAC	fast attack craft
FAE	fuel-air explosive
FAMS	Family of air missile systems
FASAT	Future anti-satellite weapon
FBM	fleet ballistic missile
FCR	fire-control radar (engagement)
FCS	fire-control system
FEL	free electron laser
FFG	Guided missile frigate
FLIR	Forward looking infra-red
FOC	full operational capability or fibre optic cable
FOFA	Follow-on forces attack
FOG	fibre optic guidance
FOV	field of view
FPA	focal plane array
FRAS	free rocket anti-submarine
FROG	free rocket over ground
FSAF	Future surface-to-air family (Aster)
FSD	full-scale development
FY	fiscal year
G&C	Guidance and control
GBI	Ground-based interceptor
GBL	Ground-based laser
GBR	Ground-based radar
GEO	Geostationary earth orbit or geosynchronous earth orbit
GLCM	Ground-launched cruise missile
GMLS	Guided missile launch system
GPS	Global positioning system
GTO	Geostationary transfer orbit
GWS	Guided weapon system (naval) (UK)
HARM	high-speed anti-radar missile
HAWK	Homing all the way killer
HE	high explosive
HEL	high energy laser
HELEX	high energy laser experimental
HEO	high earth orbit
HF	high frequency
HML	hard mobile launcher
HMMWV	high mobility multipurpose wheeled vehicle
HOE	Homing overlay experiment
HOJ	Home-on-jam
HQ	Chinese surface-to-surface missile designator

HTK hit-to-kill
HTKP hard target kill probability
HTPB Hydroxyl terminated polybutadiene (solid propellant)
HVG Hypervelocity gun
HVM Hypervelocity missile

ICBM inter-continental ballistic missile
IFF Identification friend or foe
IFTU in-flight target update
IHE Improved high explosive
IIR Imaging infra-red
IMU Inertial measurement unit
INF Intermediate range Nuclear Forces (Treaty)
IOC initial operating capability
IPP Impact point prediction
IR infra-red
IRBM Intermediate-range ballistic missile
IRFNA Inhibited red fuming nitric acid
IRST infra-red search and track
ISD in-service date

JASDF Japanese air self-defence force
JGSDF Japanese ground self-defence force
JL Chinese submarine-launched ballistic missile designator
JPO joint programme office
JTIDS joint tactical information distribution system
JVC jet vane control

KE Kinetic energy
KEW Kinetic energy weapon
kg Kilogram
Kh air-to-surface missile designator (Russian Federation)
kJ Kilojoules
KKV Kinetic kill vehicle
km Kilometres
kT Kilotonnes
kV Kilovolts
kW Kilowatts

LACM land attack cruise missile
LAD Launch assist device
LADAR laser detection and ranging
LAMS local area missile system
LATEX laser associe a une tourelle experimentale (laser system in experimental turret) (France)
LDS laser dazzle sight
LEAP Lightweight exoatmospheric projectile
LEO low earth orbit
LGB laser-guided bomb
LGM silo-launched surface attack guided missile designator (USA)
LIDAR laser (light) detection and ranging
LLADS low-level air defence system
LLTV low-light television
LM Chinese space launch vehicle designator
LORO lobe on receive only
LPAR large or long-range phased-array radar
LPP launch point prediction
LTBT Limited Test Ban Treaty
LWIR long wavelength infra-red

M Mach number (velocity relative to speed of sound)
MAD mutual assured destruction
MADS modified air defence system
MARV manoeuvring re-entry vehicle
MBT main battle tank
MEADS medium extended air defence system
MEZ missile engagement zone
MGM mobile surface attack guided missile designator (USA)
MHD magneto hydrodynamic
MHV miniature homing vehicle
MICA missile d'interception et de combat aerien (combat and air intercept missile) (France)
MIM mobilelaunched surface-to-air missile designator (USA)
MIRACL mid infra-red advanced chemical laser
MIRV multiple independently targeted reentry vehicle
MJ Megajoules
MLRS multiple launch rocket system
MM Minuteman series
MMW millimetric wave
MoU Memorandum of Understanding
MRCLOS Missile reference command to line of sight
MRV Multiple re-entry vehicle
MSAM medium-range surface-to-air missile
MSBS mer-sol balistique strategique (submarine-launched ballistic missile) (France)
MT Megatonnes
MTBF mean time between failures
MTCR Missile Technology Control Regime
MW Megawatts
MWIR medium wave infra-red
NAAWS NATO anti-air warfare system

NATO North Atlantic Treaty Organisation
NBC nuclear, biological, chemical
NDB nuclear depth bomb
NLOS non-line of sight
NMD national missile defence
NOAH Norwegian adapted HAWK
NPO design and manufacturing facility (Russian Federation)
NPT Non-Proliferation Treaty
NSSMS NATO Sea Sparrow surface missile system
NTBT Nuclear Test Ban Treaty

OKB missile design bureau (Russian Federation)
OST Outer Space Treaty
OTHR over-the-horizon radar
PAC penetration aid carrier or Patriot advanced capability
PAL permissive action link
PAR phased-array radar

PATRIOT phased-array tracking to intercept on target
PBV post-boost vehicle
PC(G) guided missile patrol craft
PD point defence
PDMS point defence missile system
PGM precision guided munition (guided bomb)
PIF pilotage in force (control by thrust)
PIP product improvement programme
Pk probability of kill
PLS palletised loading system
PRC People's Republic of China
PRF pulse repetition frequency
PSLV polar satellite launch vehicle
PVO Homeland Defence Force (Russian Federation)

R&D research and development
RAM radar absorbent material
RCS radar cross-section
RDL rapid deployment launcher
RF radio frequency
RFP request for proposals
RGM ship-launched surface attack missile designator (USA)
RIM ship-launched surfaceto-air missile designator (USA)
RPM revolutions per minute
RPV remotely piloted vehicle
ROR range only radar
ROW rest of world
RV re-entry vehicle

SA Russian surface-to-air missile designator (NATO)
SAAM systeme navale d'autodefense anti-missile (naval surface-to-air anti-missile system)
SALT Strategic Arms Limitation Treaty
SAM surface-to-air missile
SAMP systeme d'autodefense moyenne portee (medium-range surface-to-air missile system)
SA-N Russian surface-to-air (navy) missile designator (NATO)
SAP semi-armour piercing
SAR synthetic aperture radar
SBI space-based interceptor
SBL spacebased laser
SBR space-based radar
SCAD subsonic cruise armed decoy
SCC Standing Consultative Commission (for ABM Treaty)

SDI	Strategic Defense Initiative
SDS	strategic defense system
SH	Russian (Sary Shagan) ABM designator (NATO)
SHORAD	short-range air defence
SICBM	small intercontinental ballistic missile
SINS	ship's inertial navigation system
SL	space launcher
SLAM	standoff land attack missile
SLBM	submarine-launched ballistic missile
SLCM	ship- or submarine-launched cruise missile
SLV	satellite launch vehicle
SNDV	strategic nuclear delivery vehicle
SNLE	sous-marines nucléaire lanceur d'engins balistique (nuclear ballistic missile submarine) (France)
SOW	standoff weapon
SRAM	short-range attack missile
SRB	solid rocket booster
SRBM	short-range ballistic missile
SRHIT	short-range hit-to-kill missile
SS	Russian surface-to-surface missile designator (NATO)
SSBN	ballistic missile nuclear-powered submarine
SSBS	sol-sol balistique strategique (surface-to-surface ballistic missile) (France)
SS-C	Russian ground-launched cruise missile designator (NATO)
SSDS	ship self-defence system
SSG	submarine with surface-to-surface missiles
SSGN	nuclear-powered submarine with surface-to-surface missiles
SSK	submarine with anti-submarine weapons
SSM	surface-to-surface missile
SSN	submarine, attack nuclear-powered
SS-N	Russian surface-to-surface missile (navy) designator (NATO)
START	Strategic Arms Reduction Treaty
SUBROC	submarine rocket
SWIR	short-wave infra-red
TADIL	tactical information datalink
TAOC	tactial air operations centre
TBM	theatre (or tactical) ballistic missile
TEL	transporter-erector-launcher vehicle
TELAR	transporter-erector-launcher and radar vehicle
TERCOM	terrain comparison or terrain contour matching
TGSM	terminally guided submunition
THAAD	theatre high-altitude area defence
THEL	tactical high-energy laser
TIR	terminal imaging radar or tracking and illuminating radar
TLAM-C	tomahawk land attack missile conventional
TLAM-D	tomahawk land attack missile submunitions warhead
TLAM-N	tomahawk land attack missile nuclear
TMD	theatre missile defence
TOM	target object map or threat object map
TT	torpedo tube
TTBT	Threshold Test Ban Treaty
TV	Television
TVC	thrust vector control
TVM	track-via-missile
TWS	track-while-scan
TWT	travelling wave tube
UAV	unmanned aerial vehicle
UCAV	unmanned combat air vehicle
UDMH	unsymmetrical dimethyl hydrazine
UGM	underwater-launched surface attack guided missile designator (USA)
UHF	ultra-high frequency
UK	United Kingdom
UOES	user operational evaluation system
USA	United States of America
USAF	United States Air Force
USMC	US Marine Corps
USN	US Navy
UUM	underwater launched underwater attack guided missile designator (USA)
UV	ultra-violet
VBO	velocity at burnout
VHF	very high frequency
VLS	vertical launch system
VSHORAD	very short range air defence
VSM	vehicle sous-marine (underwater vehicle) (France)
WFZ	weapons free zone
WMD	weapons of mass destruction
XMGM	experimental mobile-launched surface attack guided missile designator (USA)

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EDITORIAL AND ADMINISTRATION

Director: Ian Kay, e-mail: Ian.Kay@janes co.uk

Managing Editor: Simon Michell, e-mail: Simon.Michell@janes.co.uk

Group Content Manager: Anita Slade, e-mail: Anita.Slade@]anes.co.uk

Content Editing Manager: Jo Agius. e-mail: Jo.Agius@]anes.co.uk

Pre-Press Manager: Christopher Morris, e-mail: Christopher.Morris@janes.co.uk

Team Leaders: Sharon Marshall, e-mail: **Sharon.Marshall@janes.co.uk**
Neil Grace, e-mail: Neil.Grace@janes.co.uk

Production Editor: Laura Kew, e-mail: Laura.Kew@]anes.co.uk

Production Controller: Ian Buckley, email: Ian.Buckley@janes.co.uk

Content Update: Jacqui Beard, Information Collection Co-Ordinator
Tel: (+44 20) 87 00 38 08 Fax: (+44 20) 87 00 39 59
e-mail: yearbook@janes.co.uk

Jane's Information Group Limited, Sentinel House, 163 Brighton Road, Coulsdon, Surrey CR5 2YH, UK
Tel: (+44 20) 87 00 37 00 Fax: (+44 20) 87 00 37 88
e-mail: jsws@janes.co.uk

SALES OFFICE

Send Europe, Middle East and Africa enquiries to: Mike *Gwynn* – Head of Information Sales
Jane's Information Group Limited, Sentinel House, 163 Brighton Road, Coulsdon. Surrey CR5 2YH, UK
Tel: (+44 20) 87 00 37 00 Fax: (+44 20) 87 63 10 06
e-mail: info@janes.co.uk

Send USA enquiries to: Robert Loughman – Sales Director
Jane's Information Group Inc, 1340 Braddock Place, Suite 300. Alexandria, Virginia 22314-1657, USA
Tel: (+1 703) 683 37 00 Fax: (+1 703) 836 02 97 Telex: 6819193
Tel: (+1 800) 824 07 68 Fax: (+1 800) 836 02 971
e-mail: info@janes.com

Send Asia enquiries to: *David Fisher* – Group Business Manager
Jane's Information Group Asia, 5 Shenton Way, #01-01 UIC Building. Singapore 068808
Tel: (+65) 6410 1240 Fax: (+65) 6226 1185
e-mail: info@janes.com.sg

Send Australia/New Zealand enquiries to: Pauline Roberts – Business Manager
Jane's Information Group, PO Box 3502, Rozelle Delivery Centre, New South Wales 2039, Australia
Tel: (+61 2) 85 87 79 00 Fax: (+61 2) 85 87 79 01
e-mail: info@janes.thomson.com.au

ADVERTISEMENT SALES OFFICES

(Head Office)
Jane's Information Group
Sentinel House, 163 Brighton Road,
Coulsdon. Surrey CR5 2YH, UK
Tel: (+44 20) 87 00 37 00
Fax: (+44 20) 87 00 38 59/37 44
e-mail: defadsales@janes.co.uk

Richard West, Senior Key Accounts Manager
Tel: (+44 1892) 72 55 80 Fax: (+44 1892) 72 55 81
e-mail: richard.west@janes.co.uk

Kate Hamlin, Advertising Sales Manager
Tel: (+44 20) 87 00 38 53 Fax: (+44 20) 87 00 38 59/37 44
e-mail. kate.hamlin@janes.co.uk

Joni Beeden, Advertising Sales Executive
Tel: (+44 20) 87 00 39 63 Fax: (+44 20) 87 00 38 59/37 44
e-mail: joni.beeden@janes.co.uk

(USA/Canada office1
Jane's Information Group
1340 Braddock Place, Suite 300,
Alexandria, Virginia 22314-1657, USA
Tel: (+1 703) 683 37 00
Fax: (+1 703) 836 55 37
e-mail: defadsales@janes.com

USA and Canada
Katie Taplett, US Advertising Sales Director
Tel: (+1 703) 683 37 00 Fax: (+1 703) 836 55 37
e-mail: katie.taplett@janes.com

Northern USA and Eastern Canada
Harry Carter, Northeast Region Advertising Sales Managei
Tel: (+1 703) 683 37 00 Fax: (+1 703) 836 55 37
e-mail: harry.carter@janes.com

Southeastern USA
Kristin D Schulze, Advertising Sales Manager
PO Box 270190, Tampa, Florida 33688-0190
Tel: (+1 813) 961 81 32 Fax: (+1 813) 961 9642
e-mail: kristin@intnet.net

Western USA and Western Canada
Richard **L Ayer**
127 Avenida Del Mar, Suite 2A, San Clemente, California 92672
Tel: (+1 949) 366 84 55 Fax: (+1 949) 366 92 89
e-mail: ayercomm@earthlink.com

Australia: Richard West (see UK Head Office)

Benelux: Kate Hamlin (see UK Head Office)

Brazil: Katie *Taplett* (see USA address)

Corporate Accounts: Simon Kay
33 St John's Street, Crowthorne, Berkshire RG45 7NQ, UK
Tel: (+44 1344) 77 71 23 Mobile: (+44 7702) 54 96 84
Fax: (+44 1344) 77 58 85
e-mail: simon.kay@btclick.com

Eastern Europe: MCW Media & Consulting Wehrstedt
Or Uwe H Wehrstedt
Hagenbreite 9. D-06463 Ermsleben. Germany
Tel: (+49) 0700/WEHRSTEDT / (+49) 03 47 43/620 90
Fax: (+49) 03 47 43/620 91
email: info@Wehrstedt.org

France: Patrice Fevrier
BP 418, 35 avenue MacMahon,
F-75824 Paris Cedex 17. France
Tel: (+33 1) 45 72 33 11 Fax: (+33 1) 45 72 17 95
e-mail: patrice.fevrier@wanadoo.fr

Germany and Austria: *MCW Media &* Consulting Wehrstedt (see Eastern Europe)

Greece: Kate *Hamlin* (see UK Head Office)

Hong Kong: *Joni Beeden* (see UK Head Office)

India: *Joni Beeden* (see UK Head Office)

Israel Oreet – International Media
15 Kinneret Street, IL-5 1201 Bene Berak, Israel
Tel: (+972 3) 570 65 27 Fax: (+972 3) 570 65 27
e-mail: admin@oreet-marcom.com
Defence: Liat Shaham
e-mail: liat_s@oreet-marcom.com

Italy and Switzerland: Ediconsult Internazionale Srl
Piazza Fontane Marose 3, 1-16123 Genoa, Italy
Tel: (+39 010) 58 36 84 Fax: (+39 010) 56 65 78
e-mail: genova@ediconsult.com

Middle East Kare Hamlin (see UK Head Office)

Pakistan: *Joni Beeden* (see UK Head Office)

Russia: Vladimir N Usov, PO Box 98, Nizhniy Tagil.
Sverdlovsk Region. 622018, Russia
Tel/Fax: +007 3435 230268
e-mail: uvn125@uraltelecom.ru

Scandinavia: The Falsten Partnership
PO Box 2 1175, London N16 6ZG, UK
Tel: (+44 20) 88 06 23 01 Fax: (+ 44 20) 88 06 81 37
e-mail: sales@falsten.com

Singapore: Richard *West/Joni* Beeden (see UK Head Office)

South Africa: Richard Wesr (see UK Head Office)

South Korea: Infonet Group Inc
Sanbu Rennaissance Tower 902,456 Gongdukdong. Mapogu. Seoul, South Korea
Contact: Mr Jongseog Lee
Tel. (+82 2) 716 99 22
Fax: (+82 2) 716 95 31
e-mail: jslee@infonetgroup.co.kr

Spain: Via Exclusivas SL
Contact: Julio de Andres
Viriato 69SC, E-28010 Madrid, Spain
Tel: (+34 91) 448 7622 Fax: (+34 91) 446 02 14
e-mail: j.a.deandres@viaexclusivas.com

Turkey: Richard West (see UK Head Office)

ADVERTISING COPY
Linda Letori (Jane's UK Head Office)
Tel: (+44 20) 87 00 37 42 Fax: (+44 20) 87 00 38 59/37 44
e-mail: linda,letori@janes.co.uk

For North America. South America and Caribbean only:
Shanee Johnson (Jane's USA/Canada Office)
Tel: (+1 703) 683 37 00 Fax: (+1 703) 836 55 37
e-mail: shanee.johnson@janes.com

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INVESTOR IN PEOPLE

OFFENSIVE WEAPONS

A Shahab 3 missile on its TEL vehicle, displayed in Tehran in September 1998 (P A News) 1999/0054294

UNCLASSIFIED PROJECTS

There is a small number of offensive weapon systems, some probably not continued with, some in development and some in service, for which we have insufficient information to create a full entry. These are listed below in country order.

AUSTRALIA

Ikara

The Ikara Anti-Submarine Weapon (ASW) system was developed in the early 1960s to meet a Royal Australian Navy requirement for a quick-reaction, long-range, ASW torpedo delivery system. Full-scale research and development began in 1960 with the award of a contract to Hawker Siddeley Dynamics (now MBDA Missile Systems and part of EADS) using the Australian Department of Supply's (now Aerospace Technologies of Australia (ASTA))Turana target drone as the basis of the delivery system. Shipboard tests began in 1963 and the system entered production in 1965. ASTA produced two versions, M4 and M5. The M4 guidance system was designed to interface with a full tactical weapon control system, while the M5 used a simpler system with separate fire control. Development of an improved M7 longer-range version, Super Ikara, using a launcher container began in 1982 with Oto Melara but, in 1986, the Italian company decided to concentrate on Milas (see separate entry) and withdrew from the programme. Test firings were successfully carried out in September 1986, but lack of UK interest led to the programme being suspended. The Super Ikara had folding wings and was powered by a turbojet engine, giving a maximum range in excess of 100 km.

The Ikara bears a resemblance to a small aircraft with stubby, swept rectangular wings at mid-body and a conventional tailplane arrangement. All flying surfaces have antennas at their tips and there are two more antennas on each side of the forward part of the fuselage. The torpedo payload is flared into the underside of the fuselage. The overall length of Ikara is 3.42 m and the wing span is 1.52 m. Guidance of the solid-propellant-carrying vehicle to the target area, before torpedo release, is inertial aided by radio update commands. Target information from the ship's long-range sonar is fed into a computer which calculates the dropping position, taking into account the ship's own course and speed, wind effect and target movement during time of flight.

The outputs from the computer are passed to the missile via the radio link, a ship-mounted radar/radio system enabling the missile to be tracked and guided to the drop zone where command signals initiate the torpedo's release sequence. The steel-cased, cast solid-propellant rocket motor, which is a combined boost and sustainer, gives the missile a cruise speed of M0.8 and a maximum range of 25 km. The missile, with torpedo, is stored in a magazine and, when required, is automatically guided along an electrically powered rail system to an assembly room.

An Australian Ikara ASW on its launcher

There the wings are fitted and the Ikara is hydraulically lifted on to a trainable launcher which is fixed at a 55° angle.

The BRANIK (Brazilian Ikara) is a version of the M4 with modified launcher-computer interface, that carries a US Mk 46 torpedo. A dedicated missile tracking and guidance system is fully integrated with one of the ship's Ferranti FM 1600 B computers. A lightweight semi-automated missile handling system is also incorporated.

The Ikara weapon system entered service in 1965 and more than 1,200 missiles were produced for Australia, Brazil, New Zealand and the UK. In 1993 it was reported that the only Ikara still in service were the M4 variants fitted to the Brazilian Navy 'Niteroi' class frigates, with ten missiles carried per ship. It is believed that these missiles will be retired from service by 2002, but this has not been confirmed.

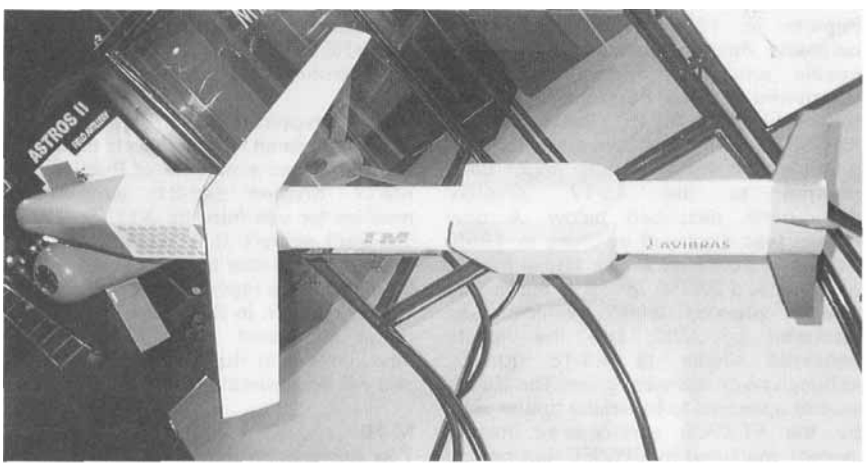
EMP Bomb

It was reported in 2000 that Australia's Defence Science and Technology Organisation (DSTO) was developing a non-nuclear Electro-Magnetic Pulse (EMP) bomb. This weapon is being developed for use against electronic components, without damaging buildings, livestock or people. EMP bombs are believed to have been developed by Russia and the USA, but second-generation weapons are expected to be more widely available by 2010. The EMP bomb will be powered by thermal batteries or a solid propellant electric pulse generator. Typical performance capabilities are expected to be with peak powers of 100 MW, an energy of 10 to 1,000 J, and a range of up to 1 km. The EMP will last for a very short time, and may be with a PRF of between 100 and 1,000 Hz.

BRAZIL

TM-Astros

Avibras Aeroespacial first displayed a model of a Tactical Missile Astros (TM-Astros) at the Paris Air Show in June 1999. This was a modified Astros II unguided rocket, adapted to provide a guided missile variant. The design was said to be complete but, as this had been a private venture, the company was looking for an export order before going into a development programme. In July 2001 an export order was placed by an unknown country, but there is no known development order from the Brazilian Army. A first test flight was made in late 1998, and further development tests have been reported from June 1999. TM-Astros has a length of 5.9 m, a diameter of 0.3 m, and an estimated launch weight of 600 kg. The payload is expected to be 140 kg, and to be a unitary HE warhead or HE submunitions. There are two folding wings behind the payload bay, and the model on display showed air intakes either side of the rear body, for a turbojet motor. The missile is believed to cruise at 200 m altitude, at a speed of M0.6. An INS/GPS guidance system would be developed if required, and in 2001 a terminal guidance system was offered as well. The initial missile will have a maximum range of 150 km, but a later version could have a range increased to 300 km. A ship-launched version has been proposed, but the initial version will be ground-launched from the existing Astros II wheeled 6 × 6 launch vehicle. Astros II unguided rockets have been exported to Iraq, Qatar and Saudi Arabia.



A model TM-Astros missile displayed at Paris in 1999 (Peter Humphris) 200110093551

CHINA, PEOPLE'S REPUBLIC

CY-I (YJ-8)

First seen in 1987, the Chinese appear to have produced an anti-submarine missile similar to the US RUR-5 ASROC system. CY-I has been seen fitted to 'Luda 3' class destroyers in four twin inclined launch canisters. The missile has a range of 18 km and carries a torpedo warhead. At launch, CY-I is 5.5 m long and weighs 700 kg. It is believed to use a Ying Ji 1 (C-801) boost and sustainer motor assembly together with a torpedo similar to the Whitehead A244. The torpedo is reported to be 2.7 m long, to have a body diameter of 0.32 m, a 34 kg HE warhead and a total weight of 220 kg. The torpedo is believed to have a range of 6 km and a speed of 30 kt. It is possible that the CY-I missile also has the Chinese designator YJ-8 and that the latest version of this missile, designated YJ-83, has been encapsulated for launch underwater from the torpedo tubes of 'Kilo' and 'Song' class submarines. However, there are contradictory reports suggesting that YJ-8 is in effect a reverse-engineered version of the SM-39 Exocet missile, with YJ-82 the encapsulated version for launch from torpedo tubes.

DF-25

The DF-25 (East Wind-25) mobile ground-launched IRBM programme was believed to be in development with an expected in-service date of 2000. This two-stage solid-propellant missile was reported to have a range of 1,700 km and a conventional HE warhead weighing 2,000 kg. The payload could be a unitary HE warhead, submunitions or chemical. The first two stages of the DF-31 missile are believed to have been used for DF-25. An unconfirmed report in 1993 suggested that this programme may be a joint project with Iran, but reports in 1996 stated that China was going to halt the DF-25 development. The halt may only have been temporary, due to problems with producing the solid-propellant motors, or the Chinese may have decided to wait until after upgrading their CSS-5 (DF-21) missiles. Reports from 1999 suggest that the DF-25 programme has been restarted, and that the expected in-service date is around 2005. An improved version, known as Mod 2, is believed to have a range of 2,500 km but with a reduced 1,000 kg payload.

Future surface-to-surface missile

Reports in 1995 suggested that a complete Russian nuclear air-to-surface missile production facility had been transferred to China. From the description this could be for AS-I6 'Kickback or the Kh-65SE (AS-I5 'Kent' derivative). It is also possible that these reports might have referred to the AS-I7 'Krypton' programme, described below. A new missile was displayed in China in 1999, described as a land attack cruise missile and also as a UAV. A model of the missile and a wheeled launch vehicle was displayed by AVIC, and the missile appeared similar to AS-I6 (Kh-15), although no details were given. The launch vehicle appeared to be similar to that used by the FT-2000 surface-to-air missile system, marketed by CPMIEC, but carried only three missile canisters. This would suggest a solid propellant missile weighing around 1,600 to 2,000 kg at launch, with a maximum range of 400 km. It is reported to cruise at 15 km altitude at M5.0, and to have a dual-mode active/passive radar seeker. The missile is believed to have a length of 6.0 m, a body diameter of 0.52 m and to carry a HE warhead between 150 and 410 kg. This missile would be too heavy for air-launch, and is expected only to be used for ground- or ship-launch.

TV-guided ASM

Unconfirmed reports in 1998 indicated that a new TV-guided air-to-surface missile was in development in China, with a range of 150 km and a launch weight of around 1,500 kg. The missile will be carried on the JH-7/FBC-1 and FC-1 aircraft, and possibly on the J-11 (Su-27/30 'Flanker'). The missile may have the designator AM!?-I. A new missile, possibly similar, was displayed in Iran in September 1998, with four delta wings at mid-body and four moving delta control fins at the rear.

YJ-9

There were unconfirmed reports in 1995 that Israel had sold some STAR-I anti-radar missiles to China and these had the Chinese designator YJ-9. However, these reports were denied. STAR-I was based upon the Delilah UAV, itself based on an early USA BQM-74 Chukar UAV design. STAR-I has a length of 2.71 m, a body diameter of 0.33 m, a launch weight of 190 kg and a blast fragmentation warhead of 30 kg. The missile is guided by a broadband passive radar seeker and has a range of 100 km. Reports also suggested that an improved version is now in development, with a range increased to 400 km and a larger warhead. It is believed that YJ-9 is also an anti-radar missile, but again there may be confusion between the STAR-I design and the AS-I7 'Krypton' programme, described below.

YJ-91/**YJ-12**

An air-to-surface missile, designated YJ-91, was first seen in model form in August 2000, under the centre fuselage of a FBC-1/JH-7 aircraft. The missile looks similar to the French ASMP, with two rectangular air-inlets each side of the body, four tail control fins, and a ramjet motor. It is believed that the YJ-91 has a range of 400 km. A similar missile has been seen, but with the designator YJ-I2, and this was described as a supersonic anti-ship missile, with a HE warhead of 205 kg, and an active radar terminal seeker.

AS-I**7 'Krypton'/Kh-31/KR-1**

There have been several reports that China has purchased a number of Russian-built AS-I7 'Krypton' (Kh-31) air-to-surface missiles for use from its J-11 (Su-27/30 'Flanker') aircraft. It is possible that the Chinese designator for this missile is YJ-9. In addition it is reported that an upgraded version, known in Russia as KR-1 with a range increased to 400 km, is in development in Russia by Zvezda Strela and will be assembled and built in China.

M-18

This designation may have referred to a two-stage solid-propellant missile with a range of 1,000 km and a 400 kg warhead. It is reported that this missile had a length of 12.0 m, a body diameter of 1.1 m, and a launch weight of 7,000 kg. There were two possible trial launches in Iran in 1991, over 700 and 1,000 km ranges, but these could have been trials of another missile (possibly a demonstration of the M-9 missile). An M-18 export model was exhibited in Beijing in 1988, which was assumed to be a further development of the M-family series following on from M-9 (CSS-6/DF-15) and M-11 (CSS-7/DF-11). It is believed that this programme was terminated in China in 1993.

wz-2000

A stealthy UCAV model was exhibited in China in 2000. This had a delta wing platform, with a rectangular body. Two turbojets were mounted on the top of the rear body, with a 'V shaped tail. The UCAV had a planned range of 1,500 km.

Nuclear bombs

The Chinese first tested a nuclear device in 1964, and this was a nuclear bomb weighing 1,550 kg with a yield of 20 kT. Their second nuclear test was made in 1965, which was an air-drop from a Tu-I6 'Badger'(H-6) bomber, and had a yield of 35 kT. It is believed that the Chinese developed three basic nuclear bomb types. A tactical nuclear bomb with a yield of 15 to 20 kT, and two strategic nuclear bombs with yields of 200 kT and 3.0 MT. The majority of the Chinese nuclear tests in the 1960s and early 1970s were using these bombs, but later tests then developed ballistic missile warheads. It is reported that the nuclear warheads were developed at the North West Nuclear Weapons Research and Design Academy, also known as the 9th Academy, at Haiyan, and at the Beijing Nuclear Weapons Research Institute. There are probably 150 tactical nuclear bombs available in China today.

Guided WM-80

A report in 1999 indicated that the Chinese company, NORINCO had developed guided (INS/GPS) and extended range versions of their WM-80 rocket series. The rockets have a length of 4.58 m, a body diameter of 0.273 m, a weight of 505 kg, and a range of 80 km. The extended range version has a range of 120 km. A 150 kg warhead can be unitary HE blast/ fragmentation or 380 submunitions. The rocket motor has 205 kg of solid propellant, which gives a peak velocity of 1.1 km/sec. The launcher vehicle uses a modified TA-550 8 × 8 wheeled chassis, and carries 8 rocket canisters with a total loaded weight of 34,000 kg. The TEL has a crew of 5, and can travel at up to 70 km/hr on roads. The original WM-80 rockets entered service in 1983.

SS-N-22 'Sunburn' **(Fu-Feng-1)**

The Chinese bought some SS-N-22 'Sunburn' ship-launched anti-ship cruise missiles from Russia for their two 'Sovremenny' class (type 956) destroyers, which were delivered in 2000 and 2001. It is believed that the Chinese are manufacturing these missiles under licence, and that they will be improved versions, with the Chinese designator Fu-

AS-17 'Krypton' (Kh-31/KR-1) air-to-surface missile (Christopher F Foss) 0022189

Feng-1. It is possible that the improved version will be fitted to the new attack submarines, type 093 'Da Bie Shan' class. The SS-N-22 has a length of 9.39 m, a body diameter of 0.76 m, a launch weight of 4.150 kg and a HE warhead of 320 kg. The missile has a supersonic cruise speed, with a solid propellant boost motor, and a ramjet for the cruise and terminal phases. Guidance is inertial with updates, with a dual-mode active/passive radar seeker. The original 3M80E version has a range of 120 km, but upgrades to 150 and 200 km were proposed in 1998, and an extended range version to 250 km has also been reported.

EGYPT

Badr 2000 or Vector

It is believed that the Egyptian Badr 2000 or Vector missile programme was simply a cover name for the Condor 2 project; Badr 2000 was the name given to the development of Condor 2 in Iraq. More details of the Condor 2 programme are given in a separate entry. Unconfirmed reports suggested ranges from 800 to 1,200 km and a warhead of 450 to 1,000 kg for Badr 2000, but it is believed that this programme was terminated in 1991. It is also possible that 'Vector' refers to Egyptian developments of the Russian SS-1 'Scud' missile system, similar to the North Korean 'Scud C' improvement programmes, with a range of 600 km and a 450 kg warhead. It is reported that North Korea has assisted the Egyptians with guidance and control equipments and helped to establish an Egyptian production line from 1995 onwards. Reports from 2000 onwards suggested that Egypt was still working on a 1,000 to 1,500 km range missile, based upon liquid propellant 'Scud' technology, and possibly similar to the North Korean No-dong 1/2 missiles.

SS-1 'Scud' improvement (Project T)

There are reports that the Egyptians, with North Korean assistance, have developed an improved version of the Russian 'Scud B' resulting in a range of 450 km. This improvement uses more modern construction materials and carries more fuel and oxidant, but is believed to retain the 985 kg warhead. It is reported that production of 'Project T improved 'Scud' started in 1990 and that 90 missiles have been built.

FRANCE

Malafon

Development of the Malafon began in 1956 in order to meet a French Navy requirement for a long-range Anti-submarine Warfare (ASW) torpedo delivery system. The concept was to design a miniature aircraft that could carry and deliver an L4 lightweight torpedo to the target area, to attack surface ships or submerged submarines. The prototype appeared in 1958 and in the next four years several test launchings were made from aircraft and land launch platforms. The first full system sea trial was conducted in 1962 and Malafon entered service in 1965.

Malafon is a miniature boost-assisted glider with short, unswept tapered wings forward of mid-body and a horizontal tailplane with tip-mounted large vertical stabilising fins. Pods on the wingtips contain flares to assist guidance. The front section of the airframe contains the rear half of the L4 torpedo, whose nose section acts as the airframe nose. The rear section of the Malafon airframe contains the SFENA/Thomson-CSF radio-command guidance system, with autopilot and radio altimeter. Beneath the rear section are two solid-propellant booster motors. The Malafon has an overall length of 6.15 m, a maximum body diameter of 0.65 m, wing span of 3.3 m and weighs 1,500 kg at launch. Guidance to the target area is inertial, assisted by a radio altimeter and radio-command updates. The missile is launched from a movable ramp mounted on a rotating turret assembly. It is propelled by the two boost motors for 3 seconds to attain a speed of 830 km/h. Subsequent flight is unpowered. The radio altimeter maintains the missile in a flat trajectory at a height of around 100 m. On reaching the target area, approximately 800 m from the target's estimated position, a tail parachute is deployed to decelerate the missile. The action aids the ejection of the torpedo from the airframe and the torpedo enters the water to complete the terminal guidance phase of the attack with acoustic homing.

The L-4 is a conventional shaped torpedo having a body made of removable sections of magnesium alloy and comprising the following major assemblies: nose section containing the guidance system, acoustic firing circuits and the warhead; centre section with battery and priming elements; tail section with compressed air reservoir, electric propulsion unit and the steering mechanism. There is also the launching device, to ensure that the torpedo makes a smooth entry into the water, comprising a parachute stabiliser/retarder release mechanism aft and an ejection cap forward. The torpedo is 3.13 m long (including parachute pack), has a body diameter of 0.533 m and weighs 525 kg with a 100 kg HE warhead.

After release from the Malafon, the torpedo descends by parachute to water entry where the parachute and nose cap are released. Once in the water the electric propulsion unit. which consists of a motor driving contrarotating propellers through a reduction gear, is activated and propels the torpedo in a predetermined circular search pattern. The torpedo continues to circle until its passive acoustic detection system locates the target. It then changes course and homes on the target when the warhead detonates either by acoustic proximity or impact fuzes. The L-4 has a range of some 6 km with a speed of 30 kt.

Some 400 Malafon Mk 2 airframes have been produced by Societe Industrielle d'Aviation Latecoere either as a new built missile or by upgrading the Mk 1. They are no longer in production and there are no known exports. The only Malafon remaining in service were carried by 'Suffren' and 'Tourville' class destroyers of the French Navy, but it is believed that the missiles were removed from the 'Tourville' class by 1996 and that the missiles on the 'Suffren' class ships became non-operational from 1997. Malafon is expected to be replaced by Milas *(Missile de Lutte Anti-Sous-marine)* around 2002/2003.

ASMPA

Designs for a successor to the nuclear air-to-surface ASMP started in the late 1980s and were originally called ASLP *(air-sol-longue portee)*. However, in 1996, the French government announced that the ASMP design would be modernised and called ASMP Plus (and then ASMP-Ameliore) and that the successor would be less expensive than the earlier ASLP design. ASMPA is expected to have a nuclear warhead with a yield of 300 kT, with a liquid fuel ramjet motor derived from the Vesta demonstrator programme and a new airframe derived from the Vector development programme. ASMPA is believed to have two rectangular air inlets each side of the body, and four moving

control fins at the tail. The missile will have a length of 5.6 m and a launch weight of 950 kg. It will cruise at M3.0 at high level, or at M2.0 at low level. ASMPA will have a range of 500 km, and is planned to enter service around 2008 for carriage on Mirage 2000N and Rafale F3 aircraft. Project definition studies were completed in 1999, and there were six ground tests of the Vesta motor in 2001. Flight tests of the Vesta and Vector projects are planned for 2002, and a full development contract for ASMPA is expected around 2003/2004.

INDIA

Sagarika

Reports in 1994 suggested that a ship- or submarine-launched land attack cruise missile, named Sagarika or Sagrika, had been in design and development since 1991, by the DRDO with the Aeronautical Development Establishment at Bangalore. The cruise missile is reported to have a turbojet engine, to cruise at high altitude (15 km) or at low level, and to have a range of 300 km when cruising at high altitude. Sagarika was reported to use terrain contour matching, INS and GPS guidance and to carry a nuclear or HE warhead. It is believed that the system was intended for use from ships and a future nuclear-powered submarine (the ATV project) and to use UAV updates during flight. In 1996, a DRDO statement implied that this programme had been terminated, probably as India was planning to purchase Russian SS-NX-27 Club missiles and to jointly develop the PJ-10 Brahmos missile with a Russian company. Later reports suggest that the project has been extensively modified, and a report in 1999 indicated that Sagarika would have a range increased to 1,000 km.

Nuclear **bomb**

India tested its first nuclear device in May 1974, followed by testing several nuclear warheads in May 1998, including a 2 to 10kT warhead that it is believed would form the basis for an aircraft-delivered nuclear bomb. The development programme has been directed by the Bhahba Atomic Research Centre. It is believed that the tactical class nuclear bomb has a 15 to 20 kT yield, and a weight of around 350 kg. Flight tests have been reported to clear the weapon on Mirage 2000H and Su-30MKI aircraft. It is assumed that a small number, probably 20 to 50, of these bombs would be available for use.

Dhanush

Reports were made in 1998 that a naval version of the Prithvi 350 short-range ballistic missile was in development by DRDO. A first test launch of Dhanush was made in April 2000, from the helicopter deck of a 'Sukanya' class offshore patrol vessel. The test used what is believed to be a standard liquid-propellant Prithvi missile, with an 800kg payload and a maximum range of 300 km. A second test was made in September 2001. It is reported that a later version may be developed, using solid propellants, which might be launched from warships, although it might also be fitted to the ATV nuclear-powered submarine.

Surya

Reports in 1994 suggested that an ICBM design, known as Surya, had been proposed based upon the civil space launch technologies of the PSLV/GSLV programmes. Surya was reported to have a length of 40.0 m, a launch weight of 80,000 kg and a range of 12,000 km. Reports in 2001 suggested that Surya 1 would have a range of up to 8,000 km, and a Surya 2 version would have a range of 12,000 km. The missile is believed to have three stages, two solid propellant and the third stage a liquid-propellant motor. A first test flight is expected by 2005, and Surya 1 is expected to enter service in 2008.

INTERNATIONAL

ANF

A joint French/German programme, known as the *Anti-Navire **Nouvelle** Generation* (ANNG) missile, was proposed as a replacement for the former joint ANS/ANF programmes which were examining successors to the MM 38/40 Exocet and AS-34 Kormoran projects. Initial plans were that ANS would enter service in 2000, then a less expensive solution, ANF, was proposed. A joint project between Aerospatiale (now MBDA Missile Systems) and LFK (part of EADS), ANNG, was announced in 1994 and would have used the ramjet motor technology used by ASMP to create a supersonic active or passive radar-guided anti-ship missile with a range of about 350 km. In 1998, a lower-cost solution, also named ANF, was proposed as a replacement for ANNG. The ANF missile is initially intended for use against ship targets, but with a possible land attack capability to be added later. ANF will be 5.8 m long, and the missile will cruise at supersonic speed, M2.3 at low level and M 3.0 at high level and have a range of around 200 km. An active radar seeker will be used in the initial version. A liquid fuel ramjet motor programme, called Vesta, was initiated to provide improved performance, particularly in manoeuvrability, for the ANF missile. A project definition contract was awarded in October 1998, but the programme was halted in January 2000. It is expected that the Vesta ramjet motor development will continue for the ASMPA programme, and could be used whenever the ANF project is restarted. The initial ANF objective was to develop a ship-launched missile to replace Exocet on French ships by 2005, an air-launched version for carriage on Rafale and Tornado aircraft by 2008, and then submarine and coastal defence versions would be developed by 2010. However, with the halt in 2000, these dates are unlikely to be met.

NSM

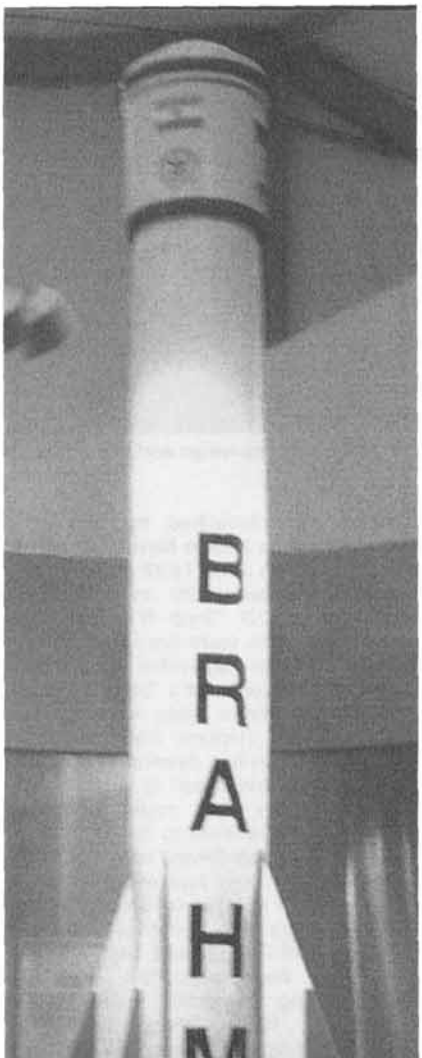
A joint programme is in development by Kongsberg Aerospace and Defence of Norway and Aerospatiale (now MBDA Missile Systems) for a 'Nytt Sjömal Missil' (New anti-Ship Missile) (NSM) as an eventual replacement for Penguin Mk 2/3, with initial use from small ships or coastal defence batteries. The new missile will have a range of 170 km and an imaging infra-red seeker. NSM will be 3.95 m long, will have a body diameter of 0.69 m, a wing span of 1.4 m, a 120kg HE blast fragmentation warhead, and a launch weight of 412 kg with a boost motor. The flight weight will be 347 kg. A Microturbo TRI-40 turbojet engine, with a weight of 44 kg, will give the missile a subsonic cruise speed around M0.85. Guidance will use INS/GPS with terrain comparison updates and a laser altimeter in mid-course, and a dual-band IIR terminal seeker. The whole nose section rotates in the roll plane, to provide improved guidance. The missiles will be fitted in a 710 kg square sectioned canister on ships, with a length of 4.1 m, and a width/height of 0.81 m. The initial requirement comes from the Royal Norwegian Navy to replace its ship-launched Penguin Mk 2 missiles, but it is expected that NSM will later be adapted for carriage from helicopters (such as the NH-90) and fixed-wing aircraft (F-16). A development contract was placed with Kongsberg in December 1996 and a co-operative agreement was signed with Aerospatiale in June 1997. An agreement was signed with TDW (DASA, part of EADS) for the development of a new warhead for NSM, and for a joint programme if the missile were to be selected for use by the German Navy. The planned in-service date is 2007. In 2001 an extended range version was proposed, with a maximum range increased to 250 km.

Polyphem **/TRIFOM**

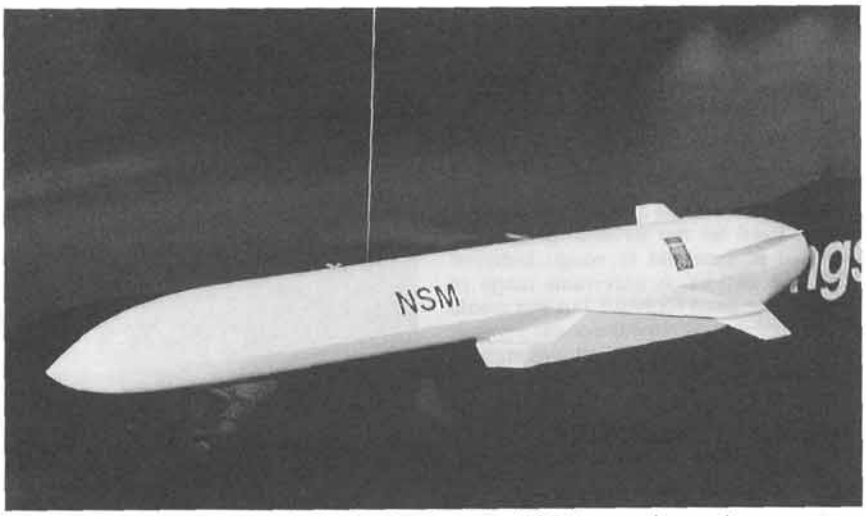
Polyphem is a joint French/German/Italian programme being undertaken by Aerospatiale (now MBDA Missile Systems), LFK and Italmissile (now part of EADS) to develop a small missile guided by TV or imaging infra-red with a fibre optic cable relaying the picture back to a controller and passing guidance commands up to the missile. A contract was placed by the three governments in July 1998 for a version known as the TRIlateral Fibre-Optic Missile (TRIFOM) for a 33 month operational evaluation phase, to be followed by full-scale development from 2002 to 2005. Polyphem is expected to be used both to attack ground and ship targets and may also be used for reconnaissance sorties.

A submarine-launched version, initially called Sub-Polyphem but now called Triton, for use from standard 533 mm torpedo tubes, has been proposed to attack land targets and as a surface-to-air missile for use against ASW helicopters. A two year demonstration programme for this version ran from 1998 to 2000. An air-to-surface missile version may also be developed for use from helicopters. A ground launch test was carried out in 1995, to trial the fibre optic cable and boost motor and a test in 1996, using a C-22 target drone, demonstrated that a 60 km cable could be unwound and used. In April 1997, the first fully guided test firing was made using a sub-scale missile with a range of 16 km.

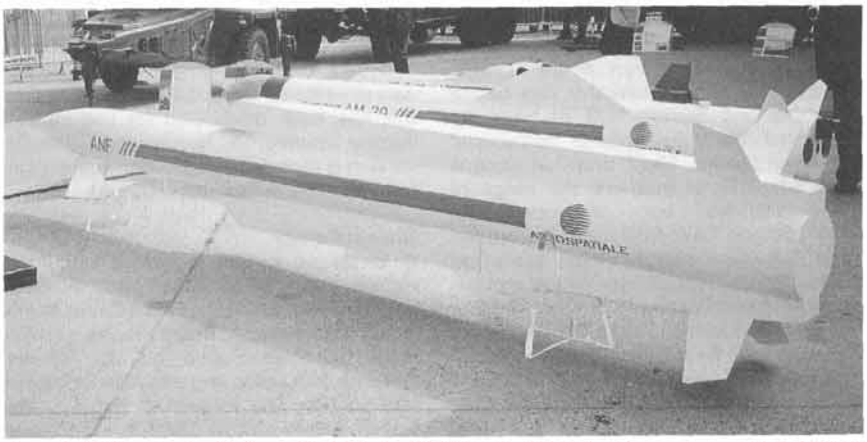
Present designs indicate a missile with a length of 2.7 m, a body diameter of 0.22 m, weight of 140kg and a range up to 60 km. Polyphem has a solid propellant boost motor and will use a Microturbo MBR 240/TRI 10 turbojet engine, with a weight of 40 kg, as the sustainer motor.



A PJ-10 BrahMos missile exhibited in August 2001, showing the nose mounted turn-over assembly over the ramjet air inlet (Kathryn Shaw) 2002/0126673



A model of the proposed NSM, displayed at Paris in 1997 (Duncan Lennox) 0022187



A model ANF missile displayed in Paris in 1999 (Peter Humphris) 2001/0093550

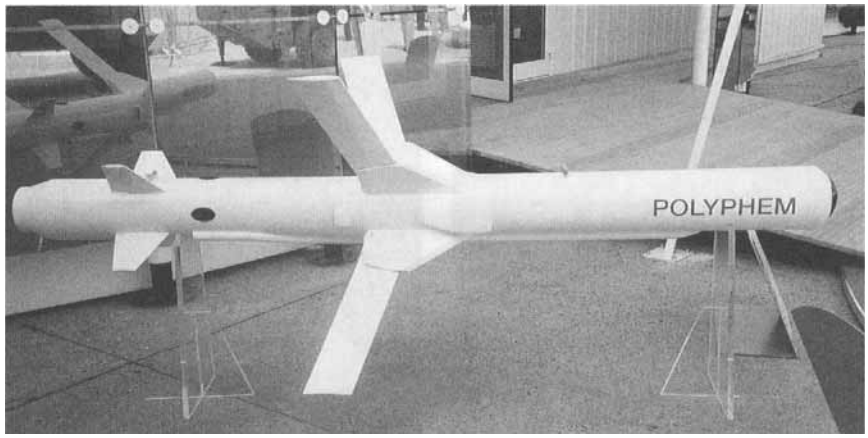
The missile is expected to have a cruise speed of 180 m/s with a cruise altitude selectable between 20 and 600 m. Guidance in mid-course will use an INS/GPS navigation system and a platinum silicide focal plane array imaging IR seeker for waypoints and terminal guidance. The IIR seeker is reported to be able to detect targets at up to 6 km range. A gyrostabilised IIR seeker has been tested since 1999. Polyphem has a 25 kg HE warhead, which separates shortly before impacting the target and is accelerated into the target by a solid propellant motor to give an impact speed of M1.4. The missile is launched from an inclined ramp, with a solid-propellant boost motor assembly that burns for 4 seconds. It is planned for launch from a 4 × 4 wheeled vehicle with eight to 12 launch canisters, from small ships or submarines. The German Navy plans to fit Polyphem to its Class 130 corvettes, with 8 missiles in four twin VLS.

The Triton submarine-launched version has some 60 per cent commonality with Polyphem, and is planned to be fitted to German Class 212 submarines, with an estimated in-service date of 2007. An unconfirmed report suggests that a privately funded development programme was started with Triton, for Israel, to fit the missiles to the 'Dolphin' class submarines. Triton will have a solid-propellant boost and sustainer motor, and a maximum range of 15 km. It will use the Polyphem 25 kg HE warhead and IIR terminal seeker. The missile will be 2.0 m long, have a body diameter of 0.22 m and a launch weight of 120 kg. There will be four wraparound wings at the rear and four extending nose control fins. Triton missiles are expected to be loaded into canisters with two missiles in-line top and two more in-line at the bottom, and then the canister placed into a standard 533 mm torpedo tube. The missiles will be fired from the canister in the torpedo tube, using the boost motor to propel the missile through the water and to broach the surface.

PJ-10 BrahMos

A joint venture was created in 1998 between the Indian DRDO and the Russian company NPO Mashinostroenia forming a company called BrahMos Pvt Ltd in India. to develop a missile called BrahMos and designated PJ-10. The missile has been developed from the Russian SS-NX-26 Oniks/Yakhont/Bastion 3M55 system, for use as an anti-ship or land attack cruise missile. PJ-10 will be capable of launch from a ground TEL vehicle, based on a Tatra T816 wheeled chassis, from ships, from canisters fitted onto the sides of submarines, or from aircraft such as the Su-30 MKI 'Flanker' or possibly the leased Russian Tu-22M3 'Backfire'. For ground, ship or submarine applications the missiles will be cold launched from VLS, with a nose mounted thruster assembly over the ramjet intake to turn the missile onto its required

trajectory. The PJ-10 missile will be 8.1 m long, have a body diameter of 0.67 m, and a weight of 3,000 kg. It will have a liquid fuel ramjet motor, and will cruise at M2.8 at around 15 km altitude, and descend to 10 m altitude for the terminal phase. Guidance will be INS for the anti-ship version, and INS/GPS for the land attack version. A dual-mode active/passive radar will be used for the terminal phase. The warhead is expected to weigh between 200 and 250 kg. A maximum range of 300 km has been reported, but this would be reduced to 120 km if the cruise phase is at low level. The first test flight was made in June 2001, and a planned Indian in-service date is 2003. A feasibility study is reported to be looking at the options for fitting PJ-10 missile canisters onto Kilo class submarines.



A Polyphem (TRIFOM) missile displayed at Paris in 1999, with the wings and fins extended (Peter Humphris) 2001/0093549

IRAN

CSSC-2 'Silkworm' **variant/Pirouzi 75**

Both China and North Korea manufactured the CSSC-2 'Silkworm' (HY-1) missiles and some were sold to Iran in the 1980s. Reports from Iran indicate that they began assembly and manufacture of both the 'Silkworm' (HY-1) and CSSC-3 'Seersucker' (HY-2) versions in 1987, and that designs were available to increase the range of these missiles. Iraq developed the FAW-150 and FAW-200 missiles from the basic 'Silkworm' design, simply extending the fuel tanks to give longer ranges and it is possible that an example of these fell into Iranian hands in the mid-1980s during the war with Iraq. Reports in 1993 suggested that Iran was developing a 400 km range variant of the basic 'Silkworm' missile, that would be a cruise missile. The 'Silkworm' warhead weighs 400 kg, but the 'Seersucker' version has a 513 kg warhead; either of these would be large enough to convert to nuclear or chemical warheads. An 'improved Silkworm' missile was test launched in November 1996 during Iranian exercises, with the Iranian name Pirouzi 75. However, there must be some doubt about this programme, as Iran is also believed to be developing the capability to manufacture the more advanced Chinese Ying Ji-1 and -2 (C-801 and C-802). and may have terminated the Pirouzi 75 programme. In 2001 there was a report that Iran had purchased a version of the Chinese FL-1 (CSS-N-1 'Scrubbrush Mod 2') missile, with the Chinese designator FL-IO. FL-1 was similar in size and shape to the earlier 'Silkworm' design, and it is not clear which missiles Iran actually has in service.

Karus/Tondar

Reports in June 1996 suggested that Iran was developing two cruise missiles called Karus and Tondar. It is believed that Karus refers to the Chinese Ying Ji-1 (C-801) solid-propellant missile with a range of 40 km, and that Tondar refers to the Ying Ji-2 (C-802) turbojet-powered missile with a range of 120 km. Both missiles can be launched from ships, ground vehicles or aircraft, and it is reported that Iran plans to assemble and then manufacture both versions. The Tondar missiles are reported to have been fitted to Iranian Navy 'Hudong' class fast attack craft in 1997, but these were more likely to have been Chinese-built C-802 missiles. Some Iranian C-802 or Tondar missiles have also been reported to have been deployed on vehicles, for coastal defence. In 1998, a Tolloue 4 turbojet engine, weighing 55 kg, was exhibited in Iran, and it is believed that this has been developed for use on the Tondar missile. A longer-range Tondar version is reported to be in development in Iran, possibly called Fadj-e-Darya.

Nazeat Family

A series of surface-to-surface unguided rockets has been developed in Iran, probably with assistance from China, North Korea or, perhaps, Brazil. These rockets have been developed by the Iranian Defence Industries Organisation since the late 1970s. The largest of these is the Nazeat family and, in 1996, the IDIO was offering Nazeat 4, 5, 6, 7, 8, 9 and 10 versions for export. The Nazeat N5 was developed in the mid-1980s. has a length of 6.0 m, a body diameter of 0.36 m and a launch weight of 850 kg. This unguided rocket has a 150 kg warhead and a maximum range of 105 km. It is believed that Nazeat N5 and N6 rockets were used against Iraq in 1987/88 and that the N6, with a range of 120 to 130 km, might have been given the name Mushak 120 or Iran 130. The Nazeat N10 version is 6.3 m long, has a body diameter of 0.45 m, a launch weight of 1,850 kg, a warhead of 250 kg and a range of 150 km. It is possible that this version has also been referred to as the Mushak 160 or Zelzal 2. N10 is reported to have entered service in Iran in 1996. A report in June 1997 suggested that the Chinese were developing a new motor for the Nazeat N10 rockets, known as NP-110, to give the unguided rocket a range increased to 160 km.

SS-1c 'Scud **B'** variant

The Iranian government stated that Iran had a ballistic missile production capability in 1987 and this was repeated in 1991. It is believed that this refers to a 320 km range 'Scud B' variant developed with Chinese or North Korean assistance, and it is reported that the first test launch was made in 1988. Iran is reported to have purchased some 'Scud B' missiles from Syria in 1985 and about 120 North Korean 'Scud B' variant missiles in 1987. Iran fired 13 'Scud B' missiles against Iraq in 1985, and 76 missiles in 1988. Four 'Scud B' missiles were launched by Iran at a guerrilla base in Iraq in November 1994, three missiles in June 1999 and a further five in November 1999. In April 2001 some 40 to 70 'Scud B' missiles or unguided rockets were fired from Iran at terrorist bases in Iraq within a three hour period. A test launch of a 'Scud B' missile was reported from a barge in the Caspian Sea in 1998. Reports from the USA suggest that Iran has developed chemical warheads for the 'Scud B' variant. The Iranian missiles, that might be called Shahab 1, are believed to have a 985 kg warhead. An unconfirmed report in 1996 suggested that Iran had exported some Scud-B variant missiles to Sudan, but this was denied by both countries. A second report in 1999 suggested that Iran and Syria may have supported a missile manufacturing capability in Sudan. In December 1999 there was an unconfirmed report that Iran was supplying 'Scud B' missiles to the Democratic Republic of Congo.

SS-1d 'Scud C' variant

Reports from Iran indicate that there is a manufacturing capability for the North Korean 'Scud' improvement (Scud-C variant), a missile with a 500 kg warhead and a range of 550 km. Reports indicate that 170 missile sets have been assembled, following the first trial launches in 1991. It is possible that Iran called this programme Shahab 2, and assistance may have been given by Iran to Syria to help that country develop an assembly and production capability for the 'Scud C'. Reports from the USA in 1997 suggested that Iran has built tunnel complexes at several locations along the Gulf Coast for 'Scud C' and larger ballistic missile facilities. It is believed that Iran has converted 'Scud B' MAZ 543 TELs to carry the 'Scud C' variant as well. A test of a 'Scud D variant' missile by Syria in September 2000, with a range increased to 650 km, suggests that a similar improvement may be developed by Iran.

M-11 variant/Fateh 110

There are unconfirmed reports that Iran is developing a longer-range variant of the Chinese M-11 (DF-11/CSS-7) solid-propellant ballistic missile. This missile might have the Iranian designator Shahab 1 (although this name might refer to the

'Scud B' variant) or Tondar 68. Pakistan launched the Shaheen 1 in April 1999 and it is possible that Iran has a similar programme. There have been several reports from Israel that Iran and Syria are developing a solid propellant missile together, but no further details have been given. The Iranian version is believed to have a warhead weight of 500 kg and a range of 400 km. The warhead probably separates inflight and this missile would be considerably more accurate and easier to use than the 'Scud B variant'. The Chinese designed the M-11 to be launchable from the Russian MAZ 543 'Scud B' launch vehicle and it should not be difficult for Iran to use any of its 'Scud B' TELS for the M-11 variant. In May 2001 Iran announced that it had successfully tested a new solid propellant missile, called Fateh 110, and it is possible that this is based upon the Chinese M-11 design. The Fateh 110 was developed by Iranian Aircraft Industries. but the status of this programme is not clear.

M-9 variant
There are also unconfirmed reports that Iran is developing a second solid-propellant ballistic missile, based upon the Chinese M-9 (DF-15/CSS-6) design. This missile might have the Iranian designator Shahab 2 (although this name might refer to the 'Scud C' variant). The Iranian version is believed to have a warhead weight of 320 kg and a range of 800 km. The warhead probably separates in flight and this missile would be considerably more accurate and easier to use than the 'Scud C' variant. It is possible that the Chinese made a demonstration launch of this missile in Iran in 1991 and that the May 1996 launch was, in fact, the first Iranian test of this missile. Pakistan is believed to have a similar programme and to have conducted its first test flight in July 1997, although Pakistan's Shaheen 1 appears to be a scaled-up version of the Chinese M-11 rather than the M-9. The Iranian M-9 variant could be launched from standard 'Scud B' launch vehicles already in service in Iran, with only minor modifications. The status of this programme is not known.

Shahab ***5/6***
Unconfirmed reports suggest that Iran is developing either a solid-propellant, three-stage, intermediate-range ballistic missile, or a liquid/solid-propellant satellite launch vehicle, with a programme that started in 1997. However, there is confusion between the Shahab 4 and these two programmes. It is possible that these reports refer to the Shahab 5 and 6 missiles, believed to be IRBM and satellite-launch vehicles based upon a similar North Korean project known as Taep'o-dong 2. The IRBM version has been given a range of 4,500 km.

Zelzal-1/-2/-3
There were reports in 1996 which indicated that Iran had three solid-propellant missile development programmes, called Zelzal-1, Zelzal-2 and Zelzal-3. There has been confusion about these reports, as the IDIO offered a Zelzal-2 unguided rocket for sale in 1996, which appeared similar to the Nazeat N10 (see above). Zelzal-2 has a length of 8.46 m, a body diameter of 0.61 m, and a launch weight of 3,545 kg. This rocket carries a warhead of 600 kg, and has a maximum range of 200 km. Reports suggest that the Iranians might use different programme names in development and production. However, this has not been confirmed. There are no reports of a Zelzal-1, but an unguided rocket designated Zelzal-3 was displayed in Tehran in September 1999, with a range believed to be between 150 and 200 km. An unconfirmed report in 2001 suggested that a Zelzal-3 upgrade would provide INS guidance and two solid propellant strap-on boosters, with a range of up to 400 km.

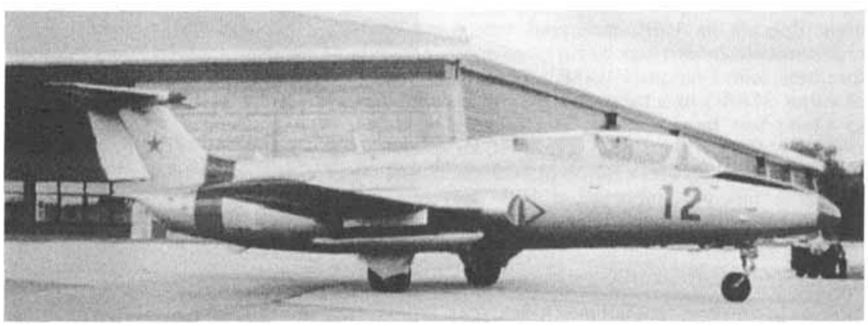
IRAQ
Ababil
An air-to-surface missile was displayed in Baghdad in 1988 that appeared to be similar in shape to the Mirach-100 UAV, although there may be no connection between the programmes. Ababil had a turbojet engine at the rear, two swept wings under the centrebody and a flattened nose with what appeared to be a TV terminal seeker. It is believed that this missile was 6.0 m long, had a launch weight of about 1,000 kg and a range around 500 km. Reports in 1995 indicated that Iraq had developed biological warheads for a UAV project. It is assumed that the development was halted in 1991 but, following the withdrawal of UN inspectors in August 1998, it may have been restarted.

IRBM
The UN inspectors confirmed in 1995 that Iraq had designed three missiles with ranges of 900, 2,000 and 3,000 km. A separate reference has been made to a missile called 'Al Hanza', believed to have been a solid-propellant ballistic missile with a range of 1,200 to 1,500 km. The interception of 115 guidance gyros, reported to have been removed from Russian SS-N-18 submarine-launched ballistic missiles, added to defectors' claims about these programmes. Later reports suggested that the 3,000 km missile has a 200 kg payload, which would indicate an intention to use a biological warhead. Further reports in 2001 suggest that a larger nuclear warhead is planned for the 3,000 km missile, and that Iraq has designed re-entry vehicles for these missiles.

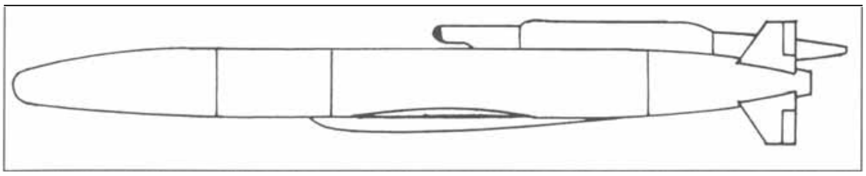
L-29 Delfin Aircraft Conversion
Reports in December 1998 indicated that Iraq had been modifying several L-29 Delfin two-seat training aircraft for use as UCAVs, to carry two 100 kg chemical or biological weapons. Some 3,500 Delfin aircraft were built between 1963 and 1974 and some may have been bought on the world's second-hand market. The L-29 has a range of 640 km on internal fuel, with a flight speed of M0.75. Some modified Iraqi aircraft are believed to have been destroyed during Operation Desert Fox in December 1998, but reports in 2001 indicate that further aircraft are being modified. Iraq has L-39 Albatross jet trainers in service and it is quite possible that these or further L-29s are being used in a conversion programme.

SRBM (Sakr/Ababil-100/-150)
There have been continued reports that Iraq has been developing a new Short-Range Ballistic Missile (SRBM) since late 1991, with a range initially limited to 150 km to comply with the UN Security Council resolutions, but increased since 1998 following the removal of the UN inspection teams. Research into missile-related technologies is reported to have been centralised at Ibn al Haytham research facility. This SRBM programme has been given several names; Sakr and Ababil-100/-150 are most widely used. The missile has a solid-propellant motor and it is reported that Iraq had an SS-21 'Scarab' TEL vehicle, probably obtained from Yemen in 1995, which might indicate that both missile and TEL technologies were being used by Iraq for its Sakr or Ababil project. The test and production facilities were reported to have been bombed in December 1998, but a report in August 2000 indicated that a new facility had been found at Al Mamoun some 40 km southwest of Baghdad. Two missiles on TELs were paraded in December 2001, and were reported to have a range of 150 km with a payload of 300 kg. Further designs were reported, for a Sakr 200 with a range of 200 km, and for a third version with a range of 600 km.

Al Samoud
It is unclear whether Al Samoud (or Al Samed), described as a 140 km range SRBM with a 300 kg payload, is a second programme or just a renamed Sakr/Ababil. The Al Samoud missile is a two-stage missile, with a solid-propellant first stage and a liquid-propellant second stage. Development started in 1991 and the design is based upon the Russian SA-2 'Guideline' surface-to-air missile. Iraq tested several designs of a similar missile, with the designator J-1, up to 1993 and this missile programme was not declared



L-29 Delfin trainer aircraft 2002101 26680



A line diagram of the Iraqi Ababil air-to-surface missile

to UNSCOM until 1995. Static engine tests for Al Samoud were reported in 1996 and 1997. A report in 1998 suggests that Al Samoud was first test launched in Iraq in 1995, although another report suggests 1997. A total of eight test flights had been completed by August 2000 and production is believed to have started at Ibn al Haytham in late 1998. Iraq clustered four liquid-propellant motors from the SA-2 SAM during tests in 1993, presumably in preparation for a longer-range version of Al Samoud and simulations were found by UNSCOM for two- and three-stage versions in 1996 for both IRBM and SLV projects. The test and production facilities for Al Samoud were reported to have been bombed in December 1998. Four missiles with TELs were reported to have been displayed in December 2001.

ISRAEL

Jericho 3

Unconfirmed reports suggest that a Jericho 3 ballistic missile project is in development in Israel, based upon the technologies of the 'Next' satellite launch vehicle. 'Next' is a four-stage vehicle, with three solid-propellant stages and the fourth stage liquid. Jericho 3 is believed to have a design range of 4,800 km.

Keres

The existence of the Keres Surface-to-Surface Missile (SSM) programme was confirmed by Israel in 1992, as a ground-launched variant of the AGM-78 Standard anti-radar missile sold to Israel as part of the 'Purple Fist' programme. Keres has a launch weight of about 615 kg and a range of 40 km. The missile was used against SAM radars in the Bekaa Valley conflict in 1982. It is believed that Keres was modified for a ground launch by Israeli industry.

Delilah Cruise Missile/STAR-1

The TAAS Israel Industries Delilah UAV has been modified as STAR-I, an anti-radar missile. The STAR-I missile has a weight of 190 kg and carries a 30 kg HE warhead. The missile has a NPT-151 turbojet engine, and the range is 100 km, but the missile can loiter over the target area. STAR-I has GPS-aided guidance, but is programmed before launch to fly to a designated target area. Reports in 1995 indicated that a cruise missile variant was being developed for China, with a range of 400 km. The sale of either STAR-I or a longer-range variant to China has been denied. The present Delilah UAV has a launch weight of 180 kg, a payload of 54 kg and a range of 400 km. An agreement was reported in 1997 for Turkey to build the Delilah UAV under licence.

Popeye 3

Reports in 1994 suggested that Rafael had proposed an extended-range Popeye 3 missile as a cruise missile with a range of 300 km. The Popeye 1 missile entered service in Israel in 1989 and is a 1,360 kg solid-propellant TV-guided missile with an 80 km range. Popeye 3 has been offered for export with a turbojet engine and wings added, together with a GPS/INS navigation system. In 1999 there were reports that a Popeye 3 version had been proposed for launch from submarines, as a land attack missile carrying a nuclear warhead.

Cruise Missile

Several unconfirmed reports suggest that IAI is developing a supersonic cruise missile, for launch from aircraft or submarines, to replace the Gabriel Mk 3 and Mk 4 missiles. In 1996 it was reported that Rafael has been developing missile ramjet motors under a technical demonstrator programme, and there may be some links between Rafael and Somchem in South Africa, particularly concerning the development of ramjet motors for future long-range air-to-air and air-to-surface missiles. This missile might also be being considered for use as a land attack missile carrying a nuclear warhead. A report in June 2000 suggested that a cruise missile had been tested from a 'Dolphin' class submarine, launched from a torpedo tube. This missile was reported to have a range of 1,750 km, and could carry a nuclear warhead. This report was denied by Israel. A further report in June 2001 suggested that a joint programme to develop an Advanced Naval Attack Missile (ANAM) for fitting to corvettes or fast patrol boats may have been proposed to Singapore. It is believed that this version would have a range of 200 km, and would carry an HE warhead.

JAPAN

ASM-3/XSSM-2

Mitsubishi Heavy Industries are believed to be developing a dual-role missile, ASM-3/XSSM-2, as a successor to the type 93 and 96 ASM-2 and to the type 88, 90 and 96 SSM-1. The missile will be used against ship and land targets, and is expected to have an integral solid propellant/ramjet motor with a range of 200 km. Plans are reported to include INS/GPS guidance, and a dual-mode imaging IR and active radar seeker.

KOREA, NORTH

HY-2 improvement (AG-1)

North Korea is reported to have tested a 180 km HY-2 'Silkworm'/'Seersucker' improvement anti-ship missile in 1994. A second test launch was reported in May 1997 and this missile is believed to have the designator AG-1. This could be similar to the Iraqi designed FAW-150 or -200, or based perhaps on the Chinese turbojet-powered HY-4. North Korea imported HY-1 and HY-2 missiles and components for assembly from China in the early 1970s. and has presumably converted these assembly facilities to full production facilities during the 1980s. The HY-2 improvement programme is probably now complete and may well be retrofitted into existing missile stocks.

SA-2 'Guideline' variant

There have been reports that North Korea developed a surface-to-surface variant of the Russian-designed SA-2 'Guideline' SAM, with a range of around 80 km, but these reports remain unconfirmed. However, the Chinese have developed CSS-8, believed to have been Project 8610 (M-7). which is based upon the HQ-2 SAM; and the North Korean missile might have been developed in a similar way.

SS-21 'Scarab' variant

In 1997, there were several reports that some Russian made SS-21 'Scarab' short-range ballistic missiles and their TELs had been shipped from Syria to North Korea for reverse engineering. This would provide North Korea, and presumably others as well, with guidance and solid-propellant motor technologies that could significantly improve the performance of short-range missiles.

KOREA, SOUTH

KSR ballistic missile

A series of KSR research rockets is being developed by the Korean Aerospace

A trials STAR-1 (modified Delilah UAV) being carried by an Israeli Air Force F-16 (TAAS)

Research Institute with a view to developing its own satellite launch vehicles. The KSR-1 single-stage solid-propellant sounding rocket has had two successful launches. A KSR-2 two-stage rocket is being developed and will be 11.21 m long, have a launch weight of 1,930 kg and will carry a 150 kg payload to around 200 km altitude. A three-stage rocket, KSR-3, capable of reaching an altitude of 350 km, is planned for development. Unconfirmed reports suggest that a secondary use for these rocket development programmes might be for a series of ballistic missiles with ranges from 100 to 900 km and that the first in this series will be KSR-1 (or KSR-420). It is reported that KSR-1 has a launch weight of 1,400 kg, a payload of 200 kg and a range of 150 km. In March 2001, South Korea joined the MTCR, and has received agreement from the USA to develop a 300 km range SRBM with a 500 kg payload (within the MTCR guidelines), to be able to counter any ballistic missile attacks from North Korea. South Korea tested a ballistic missile, probably only partially fuelled, over 50 km range in November 2001. There is also a proposal to develop a satellite-launch vehicle to lift 1,000 kg into LEO by 2010.

Nike-Hercules variant
(NHK-1/-2)(Hyon Mu)
South Korea developed a surface-to-surface variant of the US-designed MIM-14 Nike-Hercules SAM, with a range of about 150 km, in 1975 and this is designated NHK-1. An improved NHK-2 missile, also known as Hyon Mu, was developed from 1983 and became operational in 1987. NHK-2 has a warhead of 500 kg, a launch weight of 5,400 kg and a range of 180 km. US concerns about NHK-2 being within the US-South Korean 1979 agreement limiting South Korean ballistic missile ranges to 180 km, led to a 1990 US inspection of NHK-2 missiles which confirmed the 180 km limit but noted that modifications could increase the range to around 250 km. Unconfirmed reports suggest that a 250 km range third version, known as NHK-A, was designed but not developed. A modified NHK-2 or NHK-A was tested in April 1999 and flew 40 km, although it was reported that this missile had the capability to reach a range of 300 km.

ASM/SSM
It was reported in November 1998 that South Korea will develop an anti-ship missile, for both surface (land and ship) launch and air launch. The missile was described as being similar to RGM/AGM-84 Harpoon, with a maximum range of 200 km. This missile is expected to enter service in 2003.

LIBYA
Iltisslat or Al Fatah
A development programme by Libya, with rumoured Brazilian, Chinese and German participation, to build a ballistic missile known as Iltisslat or Al Fatah, was first reported in 1984. Little had been heard about this project since 1985, until a report in May 1990 suggested that the Al Fatah programme to develop a liquid-propellant SRBM had continued and that static motor tests of the 950 km range missile were expected. Reports continue to suggest that the programme is making slow progress, with an unsucccessful launch in 1993. An unconfirmed report links the Al Fatah programme with Iran, with joint testing and assembly plants. Further reports in 1995 suggest that Iraqi technicians are involved with the Al Fatah programme, introducing solid-propellant technology from the earlier Condor 2 programme. A limited flight trial was also reported in 1995, probably of just a first stage, with a range of 100 km. In 1996, pictures of the large underground facility being constructed at Tarhunah indicated that both chemical warheads and ballistic missile programmes might be transferred to this new site. Further reports of assistance to the Al Fatah programme in 1997 suggested that Indian. Serbian and Ukrainian engineers might also be involved. In 1999 it was reported that this project was now a solid propellant missile design, with a payload of 500 kg and a range of 1,000 km. In 2001 the Libyan government was reported to be negotiating the purchase of components of the North Korean liquid propellant No-dong 1/2 for the Al Fatah programme, with a range increased to 1,300 to 1,500 km. The negotiations might also have involved Pakistan, for components of the Ghauri 1, or Iran for Shahab 3 missile components.

'Scud B' variant
Libya is believed to have received 240 'Scud B' missiles and 80 MAZ 543 TELs from the former Soviet Union in 1976 . In September 1999 around 25 refurbished 'Scud B' launch vehicles were displayed with their missiles, and it is reported that the spares and technology to undertake the programme came from North Korea and Iran. Reports also suggest that Libya is developing its own 300 km 'Scud B' variant, with help from several other countries believed to include Egypt, Iran and North Korea. This may have an increased range to 325 km or even 400 km. A report in 1998 suggested that a programme to develop a chemical warhead for this missile had the name Al Fajer or Al Jadid. There have been reports that 'Scud B' parts being sent to Libya were intercepted in 1996 and 1999, but it is not clear if these were to refurbish old missiles or to set up a production line for new missiles.

PAKISTAN
Nuclear Bomb
Pakistan tested several nuclear warheads in May 1998, and it is believed that one was for a 2 to10 kT aircraft-delivered nuclear bomb. The operational bomb probably has a yield of 10 to 20 kT, and will probably be carried by A-5 (Q-5) Fantan or Mirage 5 aircraft. It is assumed that a small number, possibly 10 to 20, of these bombs would be available for use.

RUSSIAN FEDERATION
Alfa
The Novator NPO exhibited a model of a new design for a supersonic cruise missile known as Alfa (3M51 or ASM-MS) in 1993, and this programme is now managed by NPO Mashinostroenia. It is believed that the design work on Alfa started in 1985, but has been delayed due to lack of funding. The Alfa missile is a follow-on project using some of the components developed for the 3M55 Oniks cruise missile; Oniks has the NATO designators SS-NX-26 (Russian name Yakhont) and SSC-X-5 (Russian name Bastion) respectively for the ship- and ground-launched versions. The Alfa ship- or ground-launched version is about 6.0 m long, has a body diameter of 0.55 m and weighs 2,500 kg at launch. The air-launched version is about 5.0 m long, has a body diameter of 0.55 m and weighs 1,600 kg at launch. The missile has an HE warhead of 300 kg and a range of 300 km. Alfa has two delta-wings at mid-body and a ramjet engine with a rectangular air inlet below the centrebody of the missile, giving the missile a cruise speed of M3.0. The missile has been shown with four moving control fins at the rear. Alfa can be launched from land, ship, submarine or aircraft and can be targeted against land or ship targets. The Alfa missile is believed to have both high- and low-level cruise modes with an INS/GPS navigation system and is reported to fly at 10 to 20 m altitude during its terminal phase. An active radar seeker is reported to be in development for this missile; it is believed to be the same seeker used on the 3M55 Oniks missile. This seeker may have dual active and passive modes. In addition, it is reported that secure digital datalinks have been developed to update data to the missile and reallocate targets in flight. Alfa will use the same missile canisters as the 3M55 Oniks missiles and it is believed that Alfa will be offered as an upgrade using the same weapon control systems and launchers. In 1997, NPO Mashinostroenia stated that the Alfa programme would be in development until 2000, and it was still waiting for government funding. In 1999, an air-launched version of the 3M55 Oniks was displayed and offered for export, and in 2000 a joint project with the Indian government DRDO for the development of the PJ-10 BrahMos missile was announced. It is believed that the Alfa programme has been delayed again, awaiting funding from the Russia armed forces or an export order.

AS-18 'Kazoo' improvement
A new anti-ship missile, possibly in early development and similar to AS-18 'Kazoo' (Kh-59M/Ovod-M), was shown by Russia in 1992 with air-launched and ship-launched versions. The ship-launched version is 5.3 m long and has a launch weight of 1,000 kg. It has a solid-propellant boost motor and turbofan engine with a range of 200 km. The guidance is inertial with active radar terminal homing. The missile, however, is shown in diagrams to have what appears to be a rear-facing antenna, indicating some form of datalink back to the launch ship or for target updates from an aircraft or satellite. The air-launched version is only 5.1 m long and without the boost motor assembly weighs 850 kg at launch. The warhead for both versions is conventional High Explosive (HE), weighing 315 kg, and it is believed that a Russian version of this missile can be fitted with a tactical nuclear warhead. Nothing further has been seen of

this project and it may have been terminated.

Kh-32

A Raduga NPO development project was reported in January 2000, with the designator Kh-32. This air-to-surface missile is being developed as a replacement for the Kh-22 (AS-4 'Kitchen') missile, for carriage on upgraded Tu-22M5 'Backfire' aircraft. The missile is believed to be ramjet powered, with an active radar seeker, and a range of 500 km when released from high altitude. A Russian Air Force in-service date of 2003 to 2005 is expected.

Kh-38

A report in 1996 suggested that a new Russian air-to-surface missile, with the designator Kh-38, was in development. This missile is believed to have a launch weight of 300 kg and an imaging IR seeker. Initial flight tests were reported on an Su-25 'Frogfoot' aircraft, but it is believed that these missiles will be carried by MiG-29 'Fulcrum' and Su-27 'Flanker' aircraft. A report in 1999 stated that Kh-38 has a passive radar seeker, and it is possible that a dual-mode IIR/passive radar seeker is being developed to attack radiating and non-radiating radars.

Kh-101/-102

In October 1995, it was reported that Russia was testing a next-generation air-launched, nuclear or conventionally armed, long-range cruise missile at the air force's Ahktubinsk Air Weapons Centre. The development programme, initiated in the late 1980s, is the subsonic Raduga Kh-101. The Kh-101 was selected as a priority system for the air force following the cancellation of the AS-19 'Koala' or Kh-90 in 1992. The primary task for the designers has been the development of guidance and homing, capable of an accuracy of 10 to 20 m, compared with around 100 m required for a nuclear weapon. Such accuracy suggests the weapon is intended for use against large infrastructure targets rather than hardened targets which require even greater precision. A nuclear warhead version is believed to have the designator Kh-102. The missile is similar in shape to the Kh-55 (AS-15A) but longer and with two swept wings at mid-body. Kh-101 is believed to be 7.45 m long, and to weigh between 2,200 and 2,400 kg. Guidance is thought to be inertial with GPS and terrain comparison updates, and a TV picture comparison terminal guidance system. The navigation and homing systems and onboard software will also be used for the new Kh-SD ***(srednei dalnosti*** **–** medium-range) missile (see below). The Kh-101 and the Kh-SD will also share the same mission planning system called Sigma. The Kh-101 is believed to have a HE penetrating warhead with a weight of 400 kg, and the Kh-102 to have a nuclear warhead with a yield of 200 kT. The missile probably cruises at high level in mid-course (at around 15 km) at around M0.75 and then descends for the terminal phase to between 30 and 70 m. No details on range are available, but this could be around 3,000 km, although one Russian report suggests 5,000 km. The Kh-101 will probably be carried by Tu-160 strategic bombers (12 missiles), Tu-95MS (eight missiles) and Tu-22M3/5 (four missiles). It is believed that the initial LRIP missiles were delivered in 1999 for the start of operational evaluation, and that an initial in-service date of 2003 may be achieved.

Kh-65SE/Kh-SD

A conventional warhead cruise missile variant of the AS-15 'Kent', with the designator Kh-65SE, was shown by the Russians in 1992, with an externally mounted turbofan engine under the rear body of the missile. The missile had a length of 6.04 m, a launch weight of 1,650 kg and a range of 600 km. However, in 1995 a second similar missile known as Kh-SD ***(srednei dalnosti*** **–** medium range) was reported, but with a reduced range of 300 km. Kh-SD has the turbojet engine inside the missile body. The missile has inertial guidance with GPS and terrain comparison updates, with a TV picture comparison terminal guidance system. An alternative active radar seeker may be fitted for use against ship targets. This missile shares several components and a common Sigma mission planning system with the Kh-101 missile (see above). Kh-SD is believed to cruise at M0.75 at 15 km altitude, with a steep dive on to the target. In 1999 it was reported that the range had been increased to 600 km when cruising at high altitude (15 km). It is believed that the Kh-SD will be carried by Tu-95 'Bear-H' (14 missiles) and Tu-22M 'Backfire' aircraft (8 missiles).

SA-2 variant

Although China and North Korea are reported to have developed SSM variants of the SA-2 'Guideline' surface-to-air missile, there is no record of a similar development programme in Russia. However, in 1994 it was reported that Bosnian Serb forces in the former Yugoslavia had used modified SA-2 missiles in the surface-to-surface role and, in 1995, Croatia was reported to have made similar modifications.

SA-5 variant

Reports suggest that some SA-5 'Gammon' surface-to-air missiles were modified for use in the surface-to-surface role in Azerbaijan in 1994, and it is possible that the design work for the modifications was completed in Russia. Many SA-5 missiles were built, probably in excess of 2,000, and exported to around 15 countries. It is believed that the SA-5 could be modified to have a range of 350 to 425 km, and to carry a 217 kg HE warhead.

SS-NX-28 (3M91, Bark or Grom)

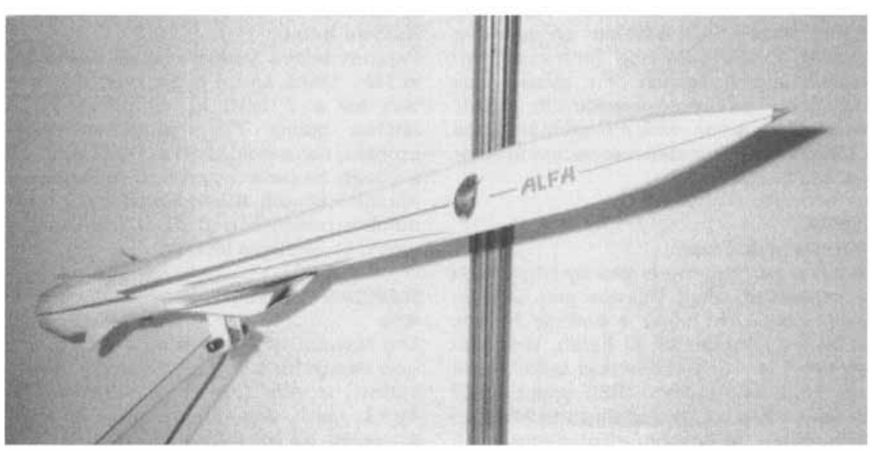
US reports suggested that a solid-propellant successor to SS-N-20 'Sturgeon' was in development in Russia, headed by the Makeyev Design Bureau. Original development started in 1985, with the missile known as R-39UT within the D-31 weapon system. The Russian designator was 3M91, and the names were Bark or Grom. It is believed that design of SS-NX-28 was completed in 1989, but that production was interrupted following the break-up of the former USSR. The first stage solid-propellant motors were designed and manufactured in Ukraine, but alternative production for these motors had to be set up in Russia. Land-based trials of the motors for the missile were carried out at the Nenoska test range, and there were three reported failures in 1997 and 1998. It was originally planned that the SS-NX-28 would be retrofitted to the 'Typhoon' class submarines, and then fitted to the new 'Borey' class (type 955) strategic ballistic missile submarines with 12 missiles per boat. However, technical and funding difficulties delayed the SS-NX-28 programme and, in 1999, it was terminated. As an interim solution new-build SS-N-23 'Skiff' missiles might be fitted to the initial 'Borey' class boats, followed by a new SLBM development programme.

SS-NX-30 (Bulava)

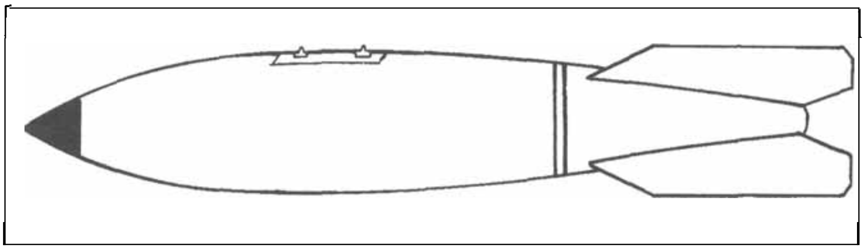
In 2001 a new SLBM programme was reported in Russia, possibly with the NATO designator SS-NX-30, but with the Russian name Bulava. This project replaces the cancelled SS-NX-28 solid propellant SLBM, and is being developed jointly between the Makeyev Design Bureau (designers of the SS-N-20 'Sturgeon') and MIT who designed the SS-27 Topol-M RS-12M1/2 ICBM. The Bulava is believed to be a three-stage solid propellant SLBM, with a range of 10,000 km.

Nuclear Bombs

The first Soviet nuclear bomb, designated RDS-1, was developed by the former Soviet Union in the late 1940s. and first tested in



A model of an Alfa ***cruise missile design exhibited by Novator NPO in 1993*** (Paul Beaver)



A Russian TN-450 tactical nuclear bomb **2002101**26677

The Kh-65SE missile, derived from the AS-15 'Kent' and exhibited in 1992

1949. The majority of Russian nuclear warheads were designed at the VNIIEF in Sarov, Nizhni Novgorod and at the VNIITF in Snezhinsk, Chelyabinsk. Strategic nuclear warheads for ballistic missiles, warheads for cruise missiles, air-to-surface missiles, surface-to-air missiles as well as strategic and tactical nuclear bombs were designed and built. Some of the bombs were also used as nuclear depth charges against submarines. The world's most powerful nuclear bomb, with a yield of 100 MT, was tested by the Russians at 50 MT in November 1961. Tactical nuclear bombs in service in Russia are believed to have the designators TN-1000 for a 1,000 kg bomb with a yield of 350 kT, and TN-1200 with a weight of 1,200 kg. A third bomb has been reported with a weight of 700 kg, and a fourth with a weight of 450 kg for carriage on supersonic aircraft such as the Su-24 'Fencer'. The 450 kg bomb, possibly with the designator TN-450, can be delivered from low level with a retarding parachute fitted, from medium level or tossed at the target. The TN-450 has a length of 3.2 m, a body diameter of 0.57 m, and has twin suspension lugs at 250 mm spacing. The yield is believed to be selectable between 20 and 200 kT.

SOUTH AFRICA

H-2/H-3(Raptor-1/-2)

Unconfirmed reports in 1995 suggested that Denel (Kentron Division) had proposed versions of its earlier Hammerhead H-2 and H-3 air-to-surface missiles for export to Pakistan. H-2 and H-3 were 1980s designs of guided bombs, reported to be standard Mk 84 (810 kg) bombs with TV guidance kits added. The H-2 design has been upgraded to Raptor-1, which has a TV seeker, GPS guidance and folding wings, with a range of 60 km when released from medium level (30,000 ft). There is a digital datalink between the launch aircraft and the guided bomb. An upgrade to incorporate an INS/GPS guidance system was reported in 1999. The Raptor-I has a length of 3.65 m, a wing span of 3.7 m, a body diameter of 0.38 m and a launch weight of 980 kg. Raptor-1 is in service with the South African Air Force. Raptor-2 is in development, this version can have TV, imaging IR or passive radar seekers, has folding wings, a twin solid-propellant motor pack under the bomb body and twin vertical tails. Raptor-2 has a launch weight of 1,200 kg, a range of 120 km and is to be fitted with an INS/GPS navigation system. The earlier H-2 and H-3 versions are believed to have been cleared for carriage on South African Air Force Mirage F1, Mirage 3 and Cheetah aircraft, which carried a datalink pod to control the missiles in flight. Raptor-I and -2 are expected to be carried by the same aircraft.

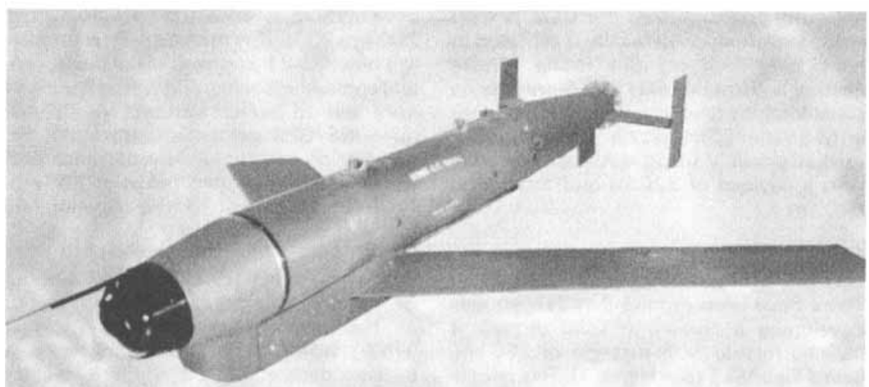
MUPSOW/Torgos

The MultiPurpose Standoff Weapon (MUPSOW) design was first reported in 1993 and was being developed by Kentron. MUPSOW was 4.5 m long, had a launch weight of 850 kg and a range of 50 km. The missile had a Mk 83 bomb as the warhead, with a weight of 415 kg and a solid-propellant motor. It is reported that both TV and imaging IR seekers were planned. A series of captive carry and drop tests was reported in 1996, with an in-service date originally planned for 2000. An improved MUPSOW was proposed in 1995, with a length increased to 4.92 m, a launch weight of 1,200 kg and a range increased to 150 km. This version was similar in appearance to the German/ Swedish Taurus KEPD-150 missile, with a turbojet engine. Ship or ground-launched versions would have a solid-propellant boost motor added. The warhead could be a Mk 83 bomb, a penetration tandem charge type, or submunitions. The improved MUPSOW would use INS/GPS guidance, with a choice of TV, IIR or MMW active radar seekers. An in-service date of 2003 was expected but. in 1999, the design had changed again and the new version is called Torgos. The rear body, tail planes and motor assembly are similar to the former Alenia Marconi Systems (now MBDA Missile Systems) Pegasus/Centaur proposal from the mid-l990s. Torgos has a length of 4.86 m, a wing span of 1.98 m, and a launch weight of 980 kg. The reduced weight enables the missile to be carried by the JAS-39 Gripen, Mirage 2000 and F-16 Fighting Falcon aircraft. Guidance will be INS/GPS with an imaging IR seeker for the terminal phase. The IIR seeker is based on the 'Kenis' development programme by Kentron, with a FPA of 384 × 288 detectors operating in the 3 to 5 micron band and with a weight of 3.5 kg. Three warhead options are being developed with a payload capacity of 500 kg, including unitary HE penetration, HE blast/fragmentation, or anti-runway submunitions. Torgos has a turbojet engine. and is expected to have a maximum range of 300 km.

SYRIA

'Scud B/C/D' variants

The assembly and manufacture of approximately 550 North Korean-designed 'Scud B'. 'Scud C' and 'Scud D' variant missiles with ranges of 300, 550 and 650 km respectively have been reported, with the first test firings carried out in July 1992. It is believed that early production started in 1993, and there have been flight trials each year since then, some development tests and some operational firings. There were seven MA2 543 vehicle chassis reportedly flown from North Korea to Syria in 1993 for adaptation as 'Scud C' TELs. It is also reported that Syria is developing chemical warheads for these missiles, both unitary and submunition



South African Raptor-1 air-to-surface missile (Kentron) **20021012 6679**

versions, and that a biological weapons programme is also in place. Flight tests of chemical warheads on 'Scud B' variant missiles were reported in 1998 and 2001. Reports from Israel stated in 1995 that Syria had a total of over 60 ballistic missile launchers for its 200 or more 'Scud B' and 60 'Scud C' variant missiles, including both imported and locally assembled missiles. A report in 1998 suggests that Syria is still building 'Scud C' variant missiles at up to 10 missiles per year and that there were plans to increase the production rate to around 50 missiles per year. Underground production facilities for these missiles were reported at Aleppo and Hama. A report in 2001 stated that Syria had built longer-range 'Scud D' variant missiles with submunition warheads, and had a total of 550 'Scud B', 'Scud C' and 'Scud D' variant missiles with 60 TEL vehicles. Syria moved 35 'Scud C' variant missiles and their TELs close to its northern border with Turkey in October 1998. Syria tested 'Scud D' variant missiles in 1999 and September 2000, and these missiles have separating warheads and a maximum range of 650 km.

M-11 variant

Reports in 1996 suggested that Syria may have obtained, or assembled, a small number (about 20) of Chinese M-11 (DF-11/CSS-7) solid-propellant ballistic missiles. It is believed that a production facility may have been set up at Hama, together with a capability to manufacture a longer-range variant. The Syrian M-11 variant is believed to have an 800 kg warhead and a range of 280 km, although this could be modified to carry a 500 kg payload over 400 km. The Syrian missile might be similar to the Pakistani-built Shaheen 1, with a payload of 1,000 kg and a range of 750 km. Alternatively, there have been reports that the Syrian missile is being developed in a joint programme with Iran, and may be connected with the Iranian Fateh 110 project, which was first tested in May 2001. However, there have been no confirmed reports or test launches of this missile.

M-9 variant

It was reported that Syria had ordered 80 Chinese M-9 (DF-15/CSS-6) solid propellant ballistic missiles together with 24 TELs around 1992, but this has never been confirmed and there have been no reported sightings. It is believed that this order was cancelled by the Chinese following pressure from the USA. A solid propellant production facility is reported to have been built at the Hama Missile Factory and it is possible that there may be plans for Syria to assemble or manufacture an M-9 variant. The missile might be similar to that possibly being developed in Iran, with a payload of 320 kg and a range of 800 km.

TAIWAN

Tien Ma 1 (Sky Horse 1)/Project Dichin

There have been reports that Taiwan was developing a two-stage solid propellant ballistic missile with a range of 950 km, called Tien Ma 1 (Sky Horse 1). This missile was reported to have a payload of 350 kg. The programme was believed to have been halted in 1993, but restarted in 1996 following the Chinese ballistic missile tests near Taiwan in 1995 and 1996. A report in 1999 suggests that the funding for this programme was increased and that the development programme is well advanced, but a report in September 2000 stated that the Tien Ma 1 programme had definitely been terminated and that a new project was being considered in its place. CSIST are reported to be developing Project Dichin, a solid propellant ballistic missile with a maximum range of 1,000 to 2,000 km. It is expected that this missile will enter service around 2005.

Tien Chi (Sky Halberd)

It was reported that the Tien Chi (Sky Halberd) ballistic missile programme involved the development of a 300 km range weapon with a 500 kg payload. However, this would have been a major re-design and not a variant of the Tien Kung 2 (Sky Bow 2) surface-to-air missile, and this was denied by the Taiwan Defence Ministry. It is believed that the Tien Chi programme is being managed by the Chung Shan Institute of Science and Technology, and has developed and tested a 120 km range missile with a 90 kg HE warhead. The missile includes an INS/GPS guidance system, and there are unconfirmed reports that some 15 to 50 missiles have been located on some off-shore islands close to the Chinese mainland.

UNITED STATES OF AMERICA

ALAM

A US Navy version of the MGM-140 ATACMS missile system, known as NAvy TACtical Missile System (NATACMS), was trialled from USS ***Mount Vernon,*** in February 1995, using an M270 launcher and Block 1A ATACMS missiles. The requirement was for a land attack missile and, in 1996, an ATACMS missile was successfully launched from a Mk 41 vertical launch assembly at White Sands missile range and NATACMS was proposed for use from both ships and submarines. In April 1998, the US Navy selected the Land Attack Standard Missile (LASM/SM-4) and upgraded Mk 45 gun for near-term development, and started a new programme to develop an Advanced Land Attack Missile (ALAM). Concept definition studies for ALAM started in 2001, with three options; NATACMS, LASM with a ramjet motor, or a new missile. Engineering and manufacturing development is expected to follow from 2004 to 2008. The missiles will be fitted to the new DD-21 Zumwalt class destroyers and some Aegis ships, and will be launched from vertical launch systems. ALAM will have INS/GPS guidance, unitary HE, HE penetration or submunitions payloads, and an expected maximum range of 500 km. An in-service date of 2010 is planned.

HAW

There have been several reports from the USA concerning the early development of a Hypersonic Aerodynamic Weapon (HAW), which would use the motors of a ballistic missile and an adapted re-entry vehicle to manoeuvre a group of kinetic energy penetrators to attack hardened targets from long range. A range approaching 5,000 km has been suggested and flight demonstrations are expected by 2003. There are reports that a single warhead with kinetic energy penetrators is being designed for the Trident D-5 missile, which could deliver a 2,800 kg payload over 12,000 km range. USAF has examined proposals to adapt Minuteman 2 or 3 ICBM for a conventional strike capability.

Guided MLRS

The US Army examined two proposals to add a guidance system to the Extended Range Multiple Launch Rocket System (ER-MLRS), which would, in effect, make a ballistic missile. ER-MLRS has a range of 50 km and a guided rocket variant, known as MLRS Smart Tactical Rocket (MSTAR) would have a nose-mounted guidance assembly with canard fins and an Inertial Navigation System (INS), considerably improving on the unguided rocket's accuracy. ER-MLRS entered low-rate initial production in 1996 and in-service deliveries started in 1998. The MSTAR proposal was planned to carry smart submunitions, such as BAT or SADARM, out to 60 km range but this was terminated in October 1999. A second proposal, which is known as Guided MLRS (GMLRS), will have a range of 60 km and engineering and manufacturing development was agreed by an international MLRS consortium of France, Germany, Italy, UK and USA in November 1998. Lockheed Martin will be the lead contractor for an international industrial team with EuroRocket Systems, which includes Diehl, FiatAvio and MBDA Missile Systems. The GMLRS upgrade will include INS/GPS, and will have around 450 M85 dual-purpose grenade HE submunitions or a unitary HE warhead. The new missile will have a length of 3.94 m, a body diameter of 0.227 m and a launch weight of 296 kg. GMLRS will be launched from the upgraded M270A1 MLRS launch vehicle, carrying 12 missiles or the HIMARS wheeled TEL vehicle carrying 6 missiles. There were five flight demonstrations between 1997 and 1999, with the first test of the new guidance assembly in May 1998. There are planned to be 35 flight tests, with multiple launches on some tests, using a total of 84 missiles. Initial production in the US is planned to start in 2002 and European production to start in 2007. The US Army are expected to order 80,000 GMLRS between 2002 and 2012, with an initial in-service date of 2004. The European consortium is expected to build 40,000 missiles. A further proposal was made by Lockheed Martin in 1999, for a Precision Over-the-horizon Land Attack Rocket (POLAR), which would use the basic GMLRS missile but with a longer solid-propellant motor to increase the range to 200 km. This missile would carry between 194 and 404 M85 submunitions, and could be launched from the RIM-7 ESSM quad-pack Mk 41 VLS launcher.

Land Attack Standard Missile (LASM)/ SM-4

Proposals from Raytheon in 1994 suggested that modified RIM-66/-67 Standard missiles could be adapted for use

as surface-to-surface missiles, with ranges between 40 and 100 km and carrying several submunitions options. Raytheon is reported to have proposed that a penetrator warhead, the BAT submunition used on MGM-140 ATACMS, or the Sensor Fuzed Weapon would have been suitable payloads. This early proposal was called 'Strike Standard'. In April 1998, the US Navy selected the Mk 45 gun and Land Attack Standard Missile (LASM) for development for use from 'Ticonderoga' class cruisers and 'Arleigh Burke' class destroyers. LASM would be built using former RIM-66/-67 Standard block 2 and 3 missiles, with the semi-active radar exchanged for an INS/GPS guidance package offering a CEP of 13 m over a range between 25 and 280 km. The missile is basically a modified SM-2MR and has been designated as SM-4. LASM will have a length of 3.94 m, a diameter of 0.343 m, and a launch weight of 751 kg. This missile will be fitted with a modified 115 kg Mk 125 unitary HE warhead, although it is believed that an alternative submunition payload using 740 M80 submunitions was also proposed. LASM is reported to use a modified Mk 104 two-stage solid-propellant motor assembly to provide an increased range capability. Three test flights were made in 1997 and 1998, and definition and risk reduction started in August 1999. Engineering and manufacturing development started in September 2000 and is planned to complete in 2003 with 12 to 15 missile firings. Initial production of 300 modification kits is expected in 2004, with up to 800 missile sets required by the US Navy.

Fast Hawk (ARRMD)

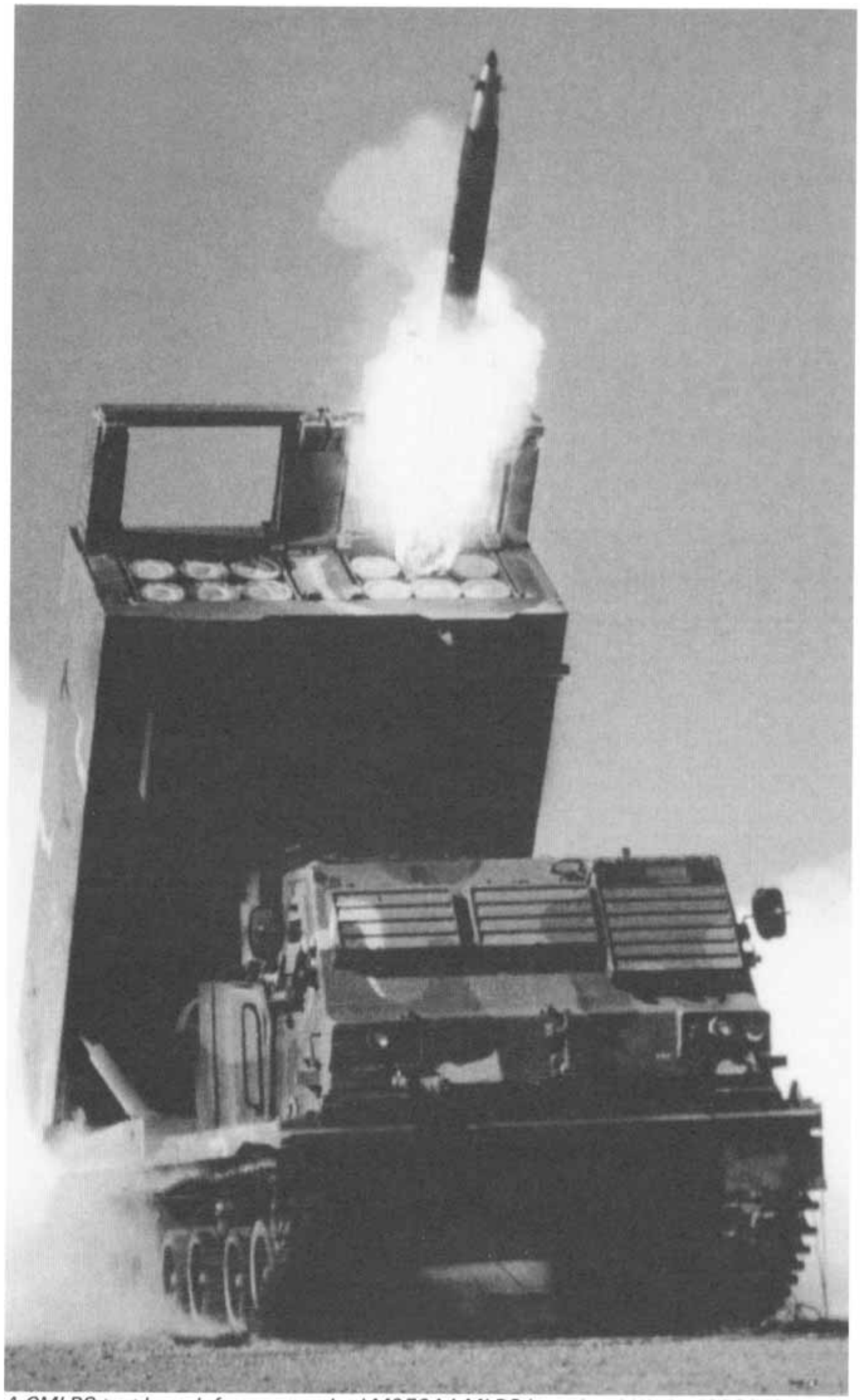
The US Navy was considering an advanced technology demonstrator programme called Fast Hawk. This would be a wingless missile with the capability of flying 1,250 km with a 315 kg payload at supersonic speed, to attack buried targets up to 12 m underground. Fast Hawk was to have a solid-propellant boost motor assembly and a ramjet motor so that the missile could cruise at M4.0 at 18 km altitude (60,000 ft). The missile would then dive on to the target, with an impact velocity expected to be in excess of 1 km/s. The missile was reported to have a length of 4.2 m, (6.5 m with the booster motor), a body diameter of 0.53 m, and a launch weight of around 1,550 kg. Flight control included a bending annular airframe and thrust vector control. It was planned that the missiles would be launched from standard Mk 41 vertical launch system canisters. A three-year demonstration contract was awarded to the US Naval Air Warfare Centre and Rockwell International (now Boeing) in 1996, but funding terminated in 1999. Boeing was then awarded a demonstrator programme by DARPA. known as the Affordable Rapid Response Missile Demonstrator (ARRMD), for a land attack missile with a range of 1,100 km and a scramjet motor providing a cruise speed of M6.0 at high altitude. It is believed that this demonstrator will scale down the Fast Hawk design, reducing the payload to 115 kg, the missile length to 4.0 m and the launch weight to 1,100 kg. ARRMD will have INS/GPS guidance, and a CEP of around 10 m. It has been proposed that submunitions will be carried, such as LOCAAS or BAT, with the missile slowing down to dispense the submunitions when these are within range of the target. The missile will be carried by internal rotary launchers on B-1 and B-2 bombers, and could also be ship-, submarine- or ground-launched. An in-service date of 2010 is forecast.

New ICBM

Two new strategic ballistic missiles were proposed in April 2001, as successors to the Minuteman III ICBM and Trident D5 SLBM. Feasibility studies are expected to start in 2004, with a Minuteman IV required in service by 2020, and a Trident E6 by 2030.

ERCM/LRCM

A USAF programme started in 2000 for an Extended Range Cruise Missile (ERCM), and three options were considered; an improved AGM-86C CALCM, an improved AGM-158 JASSM, or a conventional AGM-129 version. The missiles will have HE blast/fragmentation or HE penetration warheads fitted, and a maximum range of 1,800 km. It is expected that around 600 missiles will be ordered, with an in-service date of 2007/2008. A separate USAF



A GMLRS test launch from a standard M270A1 MLRS launch vehicle in 1998 (US Army)
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Long Range Cruise Missile (LRCM) programme is also being planned, with a range increased to 4,000 km and a datalink for re-targeting during flight and battle damage assessment. It is expected that around 1,000 missiles will be ordered, with an in-service date of 2012.

YUGOSLAVIA (FEDERAL REPUBLIC)

K-15 Krajina

A new missile was displayed in Serbia in June 1995, described as a K-15 Krajina. This is believed to be a modified SA-2 'Guideline' surface-to-air missile, converted for use as a ballistic missile with a 150 km range.

'Scud B' variants

Unconfirmed reports suggested that Serbia had a development programme for ballistic missiles at the Military Technical College in Belgrade during the 1990s. There were reported to be up to three programmes; to develop a 400 km range variant of the 'Scud **B'**, a 600 km and a 1,000 km ballistic missile. Foreign advisers could have been used to assist in any developments. Reports in 1996 suggested that some of these programmes may have been halted due to funding difficulties, but they were terminated in 1999.

SATELLITE LAUNCH VEHICLES

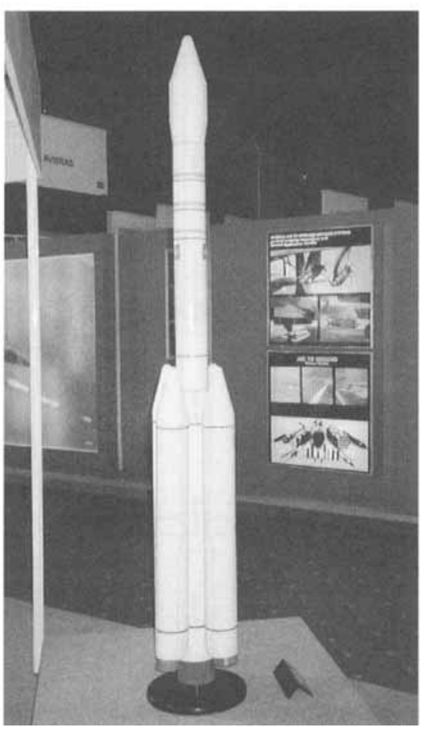
Introduction

There have been many satellite launch vehicles developed and used that are derivatives of military ballistic missile programmes, particularly in Russia and the USA. Traditionally in China, France, India, Israel, Russia and the USA there has been a close co-operation between civil and military programmes, with a relatively open exchange of technologies. It is therefore considered to be worth detailing below the principal civilian and military satellite launch vehicles in the world, without any implied connections to possible future use as ballistic missiles.

BRAZIL

Sonda 1/2/3/4

Instituto De Aeronautica E Espaco (IAE) has been responsible for developing the family of Sonda sounding rockets and the VLS orbital launcher for the Brazilian national space programme. Sonda 1 was a two-stage solid propellant vehicle that was capable of carrying a 4 kg payload up to 60 to 75 km. It was first launched in 1964, and flown more than 200 times before retirement. Sonda 2 development began in 1966 and there have been about 60 launches, carrying 50 kg payloads to 100 km. Sonda 2 is a single-stage solid propellant vehicle 4.53 m long, with a body diameter of 0.3 m, and weighs 360 kg at launch. The structural weight is 95 kg, propellant weight 237 kg, and the propellant burns for 18 seconds. In 1997, there were still three versions employed, principally for technology-proving flights. Sonda 3 development began in 1969 and provides a vehicle capable of carrying a 150 kg payload to 650 km altitude, providing three axis payload control and sea recovery. Sonda 3 is a two-stage, solid propellant launcher with an overall length of 7.0 m, a first stage body diameter of 0.56 m, a second stage diameter of 0.3 m, and a launch weight of 1,520 kg excluding payload. The first stage is 3.79 m long, has a body diameter of 0.56 m, weighs 1,205 kg and the motor has a burn time of 29 seconds. Stage 2 is a modified Sonda 2 designated S20; it is 3.2 m long, has a body diameter of 0.30 m, weighs 320 kg, and the motor has a burn time of 22 seconds. Sonda 3 was first launched in 1976 and there have been about 25 launches in total.



A model of the Brazilian VLS displayed at ***Pans** in 1997* (Duncan Lennox) 0022185

Preliminary studies of Sonda 4, offering three axis control, began in 1974 and produced the decision to launch five prototypes for vehicle qualification and as technology demonstrators for the VLS satellite launcher, which incorporates clustered Sonda 4 stage 1 motors. Sonda 4 is a two-stage, solid propellant launcher that can carry payloads of 500 kg to a height of 1,000 km. It has an overall length of 9.19 m, a first stage body diameter of 1.0 m, a second stage body diameter of 0.58 m and at launch weighs 6,800 kg excluding payload. Stage 1 is 5.37 m long, has a body diameter of 1.0 m and weighs 5,670 kg at launch. There are four swept rectangular stabilising fins at its base. The first stage solid propellant motor has a burn time of about 43 seconds. Stage 2 is 3.84 m long, has a body diameter of 0.56 m, and weighs 1,130 kg. There are four clipped in-line delta stabilising fins at its base. Its solid propellant motor weighs 869 kg, and has a burn time of 21 seconds. It is believed that the design of the Sonda 4 was utilised as the basis for the design of the SS-600 intermediate range ballistic missile but development of the latter is reported to have been terminated in 1992.

VLS

IAE, under the aegis of the Ministry of Aeronautics, is developing the Veiculo Lancador de Satelittes (VLS) four-stage space launch vehicle, designed to deliver science payloads (up to 500 kg) into low earth orbit. VLS has an overall length of 19.3 m, a body diameter of 1.0 m and weighs 50,000 kg at launch. The first stage is in effect a cluster of four strap-on Solid Rocket Booster (SRB) motors, designated S-43, attached around stage 1. The S-43 SRBs, which are derived from Sonda 4 first-stage assemblies are 9 m long, have a body diameter of 1.0 m and weigh 8,550 kg each at launch. On the prototype models the SRBs had a single clipped delta stabilising fin that provided the vehicle with a four fin tail configuration during the boost phase. The SRBs are ignited simultaneously on the pad and have a burn time of 62 seconds. In the base of each is a flexible nozzle joint that provides up to 3" TVC for three axis control from each motor. The S-43s are jettisoned after burnout. Stage 2 (core stage 1), designated S-43TM, is nested within the cluster of strap-ons. It is 8.1 m long, has a body diameter of 1.0 m and weighs 8,720 kg at launch. It contains 7.184 kg of solid propellant, which is ignited at 23 km altitude, and has a burn time of 59 seconds. A liquid propellant stage 2 is under consideration as a future upgrading. The third stage (core stage 2). designation S-40 TM, is a shortened stage 5-43 SRB and is ignited at separation. It is 5.8 m long, has a body diameter of 1.0 m and weighs 5,664 kg at launch. It contains 4,452 kg of solid propellant, and has a burn time of 56 seconds. The fourth stage (core stage 3). designation S-44, is an orbit injection motor newly developed and spin stabilised with a fixed nozzle. Stage 4 is 1.8 m long, has a body diameter of 1.0 m and weighs 1,025 kg at launch. The motor, which is ignited at 14 minutes 42 seconds after lift-off, contains 835 kg of solid propellant, and has a burn time of 68 seconds. Attitude control is by spin, initiated by solid motors before separation from the equipment bay. Stage burnout and separation from the payload occurs at 15 minutes 55 seconds after lift-off. The VLS payload assembly is separated by springs following pyrotechnic initiation just after stage 3 ignition, and has a basic weight of 150 kg. There have been test firings of stage 1, 2 and 3 motors, and a trials launch in April 1993 of a VS-40 vehicle comprising stages 2, 3 and 4. The first launch was made in November 1997, but the VLS was destroyed shortly after launch following a booster motor failure. The launch was made from the Alcantara site, with four more test launches planned. The second launch was made in December 1999, and failed when the second-stage motor did not ignite.

CANADA

Black Brant Family

Bristol Aerospace's (now part of Magellan Aerospace) current family of Black Brant (BB) solid propellant launchers consists of six basic versions: BB5, BB8, BB9, BB10, BB11 and BB12. These can deliver recoverable payloads of 70 to 850 kg to altitudes between 150 and 1,500 km from conventional missile launch rails or launcher towers. More than 800 Black Brant vehicles have flown since 1962, of which some 280 have been meteorological rockets. The single-stage BB5 forms the basis of currently available versions, with the addition of upper stages and/or US surplus first-stage boost motors.

The BB5 was first launched in 1965. It is an unguided, single-stage, solid propellant launcher designed to carry 200 kg payloads to a height of 300 km. BB5 has a length of 5.29 m plus payload bay/ nosecone, a body diameter of 0.44 m, a circular fin span of 1.51 m, and weighs 1,263 kg at launch plus payload/ nosecone. The solid propellant motor contains 1,023 kg of propellant, and has a burn time of 33 seconds. It is reported that approximately 135 operational launches of the BB5 have taken place.

BB8 was developed in 1974 as the first upgrade of the BB5 single-stage configuration, with US Army surplus Nike boosters providing a 40 per cent performance increase. It was first launched

in December 1975 and around 105 operational launches have been made. BB8 is an unguided, two-stage, solid propellant launcher designed to carry recoverable payloads of around 200 kg to a height of 460 km. It has a length of 9.0 m plus payload/nosecone, a body diameter of 0.44 m and weighs 1,850 kg plus payload/nosecone at launch. Stage 1 is a Nike M5E1 cylindrical booster motor with four clipped triangular stabilising fins at the rear end. It is 3.7 m long, has a body diameter of 0.42 m, a fin span of about 1.5 m and weighs 610 kg at launch. The motor, which contains 361 kg of solid propellant has a burn time of 3.35 seconds. Stage 2 is identical in configuration and performance to BB5. After separation from stage 1, stage 2 coasts for 5 seconds before ignition at 8.5 seconds after launch at an altitude of around 2,000 m.

The BB9 replaces the Nike motor with a US Navy surplus Terrier Mk 12 booster motor to augment the BB5 performance by 75 per cent. It was first launched in 1982 and around 110 operational launches have been made. BB9 is an unguided, two-stage, solid propellant launcher designed to carry recoverable payloads of 200 kg to a height of 500 km. It has a length of 9.56 m plus payload/nosecone, a body diameter of 0.46 m, fin span of 1.6 m and at launch weighs 2,128 kg plus payload/nosecone. Stage 1 is a Terrier Mk 12 booster motor with four clipped triangular stabilising fins at the rear end. Alternatively, the BB9 Mod 1 rocket uses a TX-664-5 motor. It is 4.27 m long, has a body diameter of 0.46 m, a fin span of about 1.6 m and weighs 878 kg at launch. The motor, which contains 534 kg of solid propellant has a burn time of 4.4 seconds. Stage 2 is identical in configuration and performance to BB5. After separation, stage 2 coasts for 7.5 seconds before ignition at 11.9 seconds after launch. BB9 is also available with Thiokol TX664 booster; 'Mod 1' is added to the BB9 designation. It provides about a further 30 per cent performance above that of the Terrier boosted BB9 but is identical in geometry.

BB10 was introduced in 1981 by adding a new Bristol Aerospace Nihka upper stage to the BB9 configuration. The flight sequence is the same as for BB9 until stage 2 burnout. It was first launched in 1981 and over 30 operational launches have been made.

BBIO is an unguided, three-stage, solid propellant launcher designed to carry a 200 kg payload to a height of 750 km. BB10 has a length of 11.88 m plus payload/nosecone, a body diameter of 0.44 m, a fin span of 1.6 m, and at launch weighs 2,560 kg plus payload/nosecone. Stage 1 is the same as the BB9 first stage, and the second stage is a BB5. BB10 Mod 1 uses a TX-664-5 motor for the first stage. Stage 3 has a Nihka 17 KS 12000 booster motor that is 1.92 m long, has a body diameter of 0.44 m and weighs 402 kg at launch. The motor, which contains 322 kg of solid propellant, has a burn time of 17.8 seconds. After stage 2 burnout, the vehicle coasts for 33 seconds until the stage 2/3 separation mechanism is activated, and stage 3 ignites at 82 seconds after launch at an altitude of around 85 km. The payload accommodation is the same as for BB5. The Thiokol TX664 booster can replace the Terrier, as for BB9.

BB12 was developed in the late 1980s by Bristol Aerospace and NASA in order to produce a launch vehicle capable of delivering a 140 kg payload to 1,500 km altitude to satisfy several physics experimental requirements. A four-stage vehicle was selected, produced by replacing the BB10's Terrier booster with US surplus Talos and Taurus motors. Two demonstration flights were made from Wallops Flight Facility, and the first operational flight was from Poker Flat (Alaska) in 1990. There have been six operational launches. BB12 is an unguided, four-stage, solid propellant launcher with a length of 16.1 m plus payload/nosecone, a body diameter of 0.44 m (upper stages) and a launch weight of 5,235 kg plus payload/nosecone. Stage 1 is a Talos booster motor with four swept rectangular stabilising fins at its rear end. It is 3.51 m long, has a body diameter of 0.79 m, a fin span of about 1.6 m and weighs 2,053 kg at launch. The motor, which contains 1,285 kg of solid propellant has a burn time of 5 seconds and an average thrust at sea level of 489 kN. Stage 2 is a Taurus cylindrical booster motor with four clipped triangular stabilising fins at its rear end. It is 4.18 m long, has a body diameter of 0.58 m, a fin span of about 1.6 m and weighs 1,361 kg at launch. The motor, which contains 755 kg of solid propellant, has a burn time of 3.3 seconds. Stages 3 and 4 are the same as those used for BBIO stages 2 and 3; stage 3 is a BB5 vehicle, and stage 4 has a Nihka 17 boost motor.

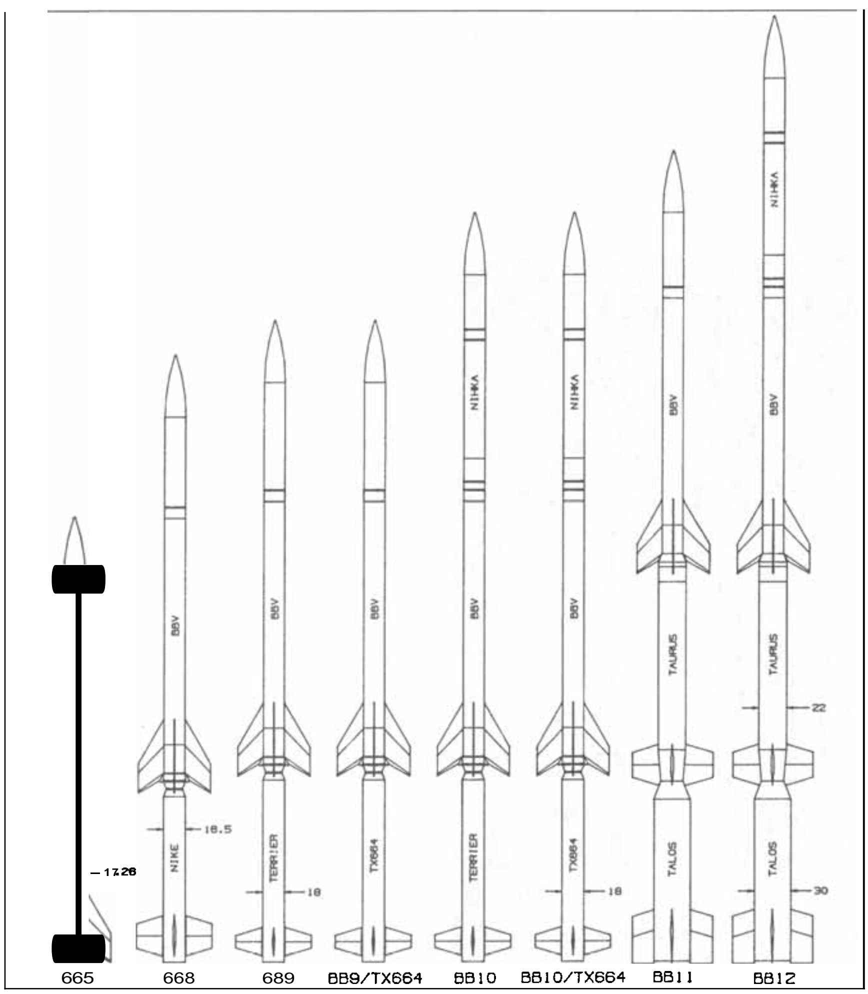
BB11 is similar to BB12 but is a three-stage rocket, without the Nihka fourth stage as used in BB12. This reduces the maximum apogee to 600 km, but BB11 can carry a 700 kg payload to 300 km altitude.

CHINA, PEOPLE'S REPUBLIC

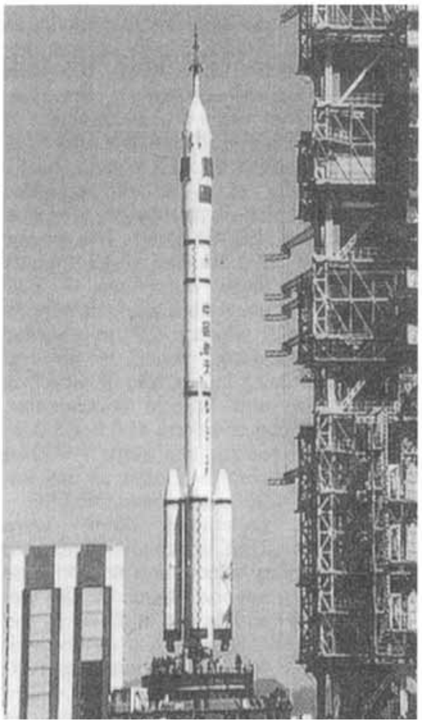
CZ-2/-2C/-2D/-2E/-2F (Long March-2)

Rocket propulsion was included in China's Twelve Year Development Plan of Science and Technology, approved in 1958. In 1965, the plan for the development of Chinese satellites was initiated, resulting in the first successful satellite launch using a CZ-1 space launch vehicle in April 1970. Since then, the core of China's launcher programme has been the CZ-2 (Chang Zheng/Long March) class vehicles. China's primary space launch manufacturing facilities are the China Academy of Launch Vehicle Technology (CALT), formerly the Beijing Wan Yuan Industry Corporation, and the Shanghai Academy of Spaceflight Technology (SAST). The CZ-2/-3/-4 family of SLV had a success rate of 55 out of 66 launches up to the end of 1999, with 20 successful launches without failure from 1996 to 2000.

The Chinese family of CZ-2 satellite launchers consists of at least five known models: CZ-2, CZ-2C. CZ-2D. CZ-2E and



The Canadian Black Brant rocket family, with dimensions in feet and inches



The CZ-2F SLV, expected to launch the first Chinese manned spacecraft into orbit
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CZ-2F. Development of the CZ-2 as a replacement for the CZ-1 family of launchers began in the late 1960s with the parallel development of the CSS-4 (DF-5) IRBM, further details of which can be found in a separate entry. The CZ-2 flew only once in 1974, and this was unsuccessful. However, an improved version, the CZ-2C. has since become a well used Chinese launcher.

Two other related developments saw the CZ-2A and CZ-2B become CZ-4 and CZ-3 respectively (for details of these see below). The CZ-2C flew its first recoverable payload mission in November 1975 and, to the end of 1997, had flown a total of 15 missions. The standard CZ-2C is a two-stage, liquid propellant launch vehicle that can carry various payloads of 750 kg to 900 km, 1,200 kg into 200 × 900 km orbit and 2,000 kg into 185 × 400 km orbit. It has an overall length of 32.57 m (39.93 m multipayload, long-fairing version), a body diameter of 3.35 m and weighs 213,000 kg at launch. Stage 1, designated L-140. is 20.5 m long, has a body diameter of 3.35 m and weighs 151,000 kg at launch. It contains 143,000 kg of liquid propellant, nitrogen tetroxide (oxidiser) in the forward tank and Unsymmetrical Dimethyl Hydrazine (UDMH) (fuel) in the aft tank. The motor assembly, designated YF-21, consists of four clustered YF-20 liquid bipropellant single start engines gimballed for steering that have a burn time of 130 seconds. Stage 2, designated L-35, is 7.5 m long, has a body diameter of 3.35 m and weighs 55,000 kg at launch. It contains 35,000 kg of liquid propellant, nitrogen tetroxide, in a forward tank and UDMH in a rear tank. The motor is a single fixed YF-22 liquid bipropellant with four YF-23 verniers for steering. Burn time for the main motor is 110 seconds, and the verniers continue to burn for a further 190 seconds. The standard payload fairing attached to the front end of stage 2 has a cone-shaped rounded nose, is 4.55 m long, and has a body diameter of 3.35 m. This carried a payload of 1,800 kg originally, increased to 2,100 kg from 1987, and 2,800 kg in 1997.

It is reported that there is a development programme to stretch CZ-2C's second stage for use with a solid upper stage in order to produce a Geostationary Transfer Orbit (GTO) launcher, known as CZ-2C/SO, and this version is scheduled for 10 operational launches.

The CZ-2D is a two-stage version of the CZ-4, which appeared unexpectedly in 1992. It was designed to carry medium class payloads into Low Earth Orbit (LEO) and, by the end of 1997, there had been three successful flights. The CZ-2D has an overall length of 37.73 m, a body diameter of 3.35 m and weighs 232,000 kg at launch. Stage 1 was the same as the CZ-4 and CZ-2E stage 1 but with fins removed and had a burn time of 153 seconds. Stage 2 was the same as CZ-4 stage 2 but with burn times of 127 seconds (main) and 136 seconds (vernier). The payload section has a length of 3.23 m, a diameter of 3.35 m and the capability of placing 3,700 kg into LEO.

The CZ-2E introduced a GTO capability into the CZ-2 family. The first launch was made in July 1990. The CZ-2E was initially described as the CZ-2-4L because of its four liquid propellant boosters, but when exhibited at the 1987 Paris Air Show it carried the current CZ-2E designation. By the end of 1997, there had been seven successful launches and two failures.

The CZ-2E is a three-stage, liquid propellant launch vehicle that can carry payloads of 3,100 kg into GTO, 7,200 kg to 400 km and 9,000 kg to 200 km. The distinctive interstage 1/2 lattice truss structure of the other CZ launchers is replaced by an aluminium shell with 60 vent holes and four access doors. The CZ-2E has an overall length of 51.17 m with 10.5 m standard nose fairing, and 52.67 m with the 12 m version. It has a body diameter of 3.35 m and at launch weighs 464,000 kg. The first stage is in effect a cluster of four strap-on liquid propellant motors, designated LB-40, attached around stage 1. These are 16.02 m long, have a body diameter of 2.25 m and each contains 38,000 kg of propellant. The engine is a YJ-20B liquid bipropellant single start engine that has a burn time of 126 seconds. Stage 2 (core stage 1), designated L-180. is nested within the cluster of strap-ons. It is a stretched CZ-2C stage 1 with uprated engines, that is 23.7 m long, and has a body diameter of 3.35 m. This stage contains 187,000 kg of liquid propellant, nitrogen tetroxide (oxidiser), in the forward tank and UDMH (fuel) in the rear tank. The power unit is four YF-20B (joint designation YF-21B) liquid bipropellant single start engines that are gimballed for steering. These have a burn time of 160 seconds. The third stage (core stage 2). designation L-90. is 15.5 m long, and has a body diameter of 3.35 m. It contains 86,000 kg of liquid propellant, nitrogen tetroxide (oxidiser), in the forward tank and UDMH (fuel) in the rear tank. The motor assembly, designated YF-24B, is an assembly of a single-fixed YF-22B, liquid bipropellant engine with four YF-23B vernier engines for steering. Burn time for the main motor is 300 seconds, verniers continue to burn for a further 413 seconds. The standard payload fairing attached to the front end of stage 2 has a cone-shaped rounded nose, is 10.5 m long, and has a body diameter of 3.35 m, but the cylindrical section can be lengthened to create a 12.0 m version. The CZ-2EA version has larger liquid strap-on boosters, a launch weight of 670,000 kg, and a capability to place 11,800 kg in LEO.

The CZ-2F was first displayed in June 1999. This SLV is part of the Chinese Project 921, which is their programme to start manned space flights. Project 921 includes a Shenzhou spacecraft, the CZ-2F launcher, ground infrastucture, a training programme for astronauts and the conversion of the three 'Yuang Wang' space-tracking ships into communications stations. Unmanned test launches were made in November 1999 and January 2001, and these will be followed by manned space flights by 2003 to 2005. The CZ-2F launch vehicle is a manned space flight version of the CZ-2E. with a payload capability of 9,500 kg into LEO. It is 50.0 m long, has four strap-on boosters, and has a launch weight of 450,000 kg. UDMH and nitrogen tetroxide are used in all four stages. The Shenzhou spacecraft is similar to the Russian Soyuz craft, but weighs 7,200 kg and is larger in order to carry a two-man crew. The spacecraft has a diameter of around 3.0 m, and is cylindrical in shape with four solar panels. A new launch pad has been built at the Jiuquan space launch centre, for both CZ-2EA and CZ-2F space launch vehicles, with a vehicle assembly building so that the vehicles can be assembled vertically and then transported vertically to the launch pad. This will allow a rapid turn-around between launches.

CZ-3/-3A/-3B/-3C (Long March-3)

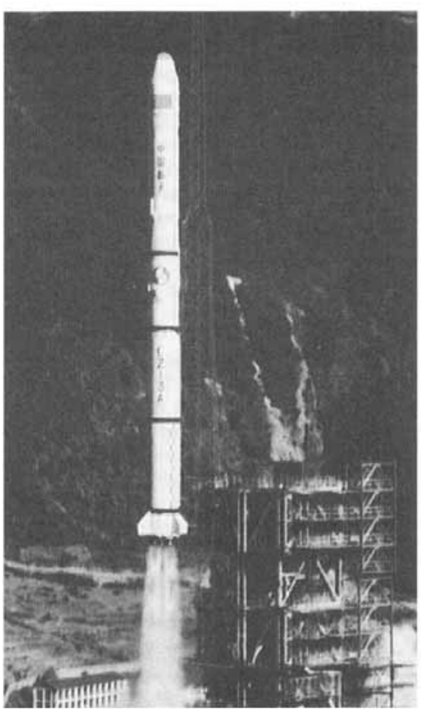
Development of a cryogenic third stage motor in order to uprate the CZ-2 into a Geostationary Orbit (GEO) class vehicle began in 1965, and at that time the vehicle was known as the CZ-2B. The cryogenic motor development programme was delayed and the first complete motor tests did not start until 1975, and re-ignition and long-burn tests took until 1983. However, when the first launch took place in January 1984, the SLV was given the designation CZ-3. The base model is offered as a launcher into GTO and was responsible for launching China's first GEO satellite. Its principal use is to carry 1,400 kg payloads into GTO, and by the end of 2001 it had carried out 15 launches with three failures. The CZ-3 has an overall length of 43.85 m, a body diameter of 3.35 m and at launch weighs 202,000 kg. The lower two stages are essentially stages 1 and 2 of the CZ-2C. and carry the same designations, L-140 and L-35 respectively. Stage 3 was the first Chinese re-startable cryogenic stage and is 7.5 m long with a body diameter of 3.35 m. It weighs 10,500 kg at launch and contains 8,500 kg of propellant, liquid oxygen (oxidiser), in the aft tank and liquid hydrogen (fuel) in the forward tank. The

engine is a cryogenic YF-73, which has four chambers fed by a single turbopump. This has a maximum burn time of 800 seconds in two burns of 500 and 300 seconds. The payload section has a length of 6.44 m, a body diameter of either 2.32 or 2.72 m. It can carry payloads of up to 4,500 kg into LEO or 1,400 kg to GEO.

An improved model, the CZ-3A, was announced in 1988 as being available commercially from 1992. However, in 1990, Chinese officials noted its introduction had been delayed until 1994. The CZ-3A incorporates an uprated stage 1 (also utilised by CZ-4) and the newly developed H-18 cryogenic stage 3. These improvements are said to have doubled the basic model's GTO capability. The first launch of a CZ-3A took place in February 1994 followed by a second in August of that year, and at the end of 2001 there had been eight launches. It has an overall length of 52.5 m, a body diameter of 3.35 m and at launch weighs 240,000 kg. The lower two stages are essentially stage 1 of the CZ-2E and stage 2 of the CZ-2C. and carry the same designations L-180 and L-35 respectively. Stage 3 is the new H-18 cryogenic stage. It is 8.83 m long, has a body diameter of 3.0 m and contains 17,600 kg of propellant, liquid oxygen (oxidiser), in the aft tank and liquid hydrogen (fuel) in the forward tank. The motor assembly is two YF-75 cryogenic dual start engines that have a maximum burn time of 470 seconds in two burns. The glass fibre payload fairing is 8.9 m long and 3.35 m in diameter, giving a payload envelope of 5.2 × 3.0 m and the ability to carry 2,600 kg into GTO or 8,500 kg to LEO.

Information emerged in 1992 that a more powerful version of the CZ-3A was being formed by adding the CZ-2E's four strap-on booster motors. This launcher, designated CZ-3B, will be used for large GTO payloads as well as having a planetary capability. The first launch was made in 1996, but was unsuccessful However, by the end of 2000, there had been five further launches that were all successful. CZ-3B has a total length of 54 8 m, a body diameter of 3.35 m and a launch weight of 426,000 kg It is believed that the second stage from CZ-3A has been lengthened The payload section has a diameter of 4 2 m, and the capability to place 5,000 kg into GTO or 12,000 kg into LEO.

In 1995, it was reported that a modified version of the CZ-3B with only two strap-ons was available This launcher is designated CZ-3C, but there have been no reported launches.



The first launch of a CZ-3A SLV. made in February 7994 (China Great Wall Industry)

CZ-4/-4A/-4B (Long March-4)

Designed in the late 1970s. the CZ-4 (originally designated CZ-2A) uses the first two stages of the CZ-3A, with a new storable propellant upper stage designed for polar orbiting meteorological payloads of 1,500 kg The first operational launch was in September 1988 and the only other recorded flight was in September 1990. The CZ-4 ıs a three-stage, liquid propellant launcher that ıs 41 88 m long, has a body diameter of 3.35 m and weighs 249,000 kg at launch. The lower two stages are essentially stages 1 and 2 of the CZ-3A and carry the same designations L-180 and L-35 respectively. However, stage 1 does have four clipped delta fins at the aft end. Stage 3 has a storable propellant L-14 that was designed specifically for, and used only by, the CZ-4. It has 14 anhydrous hydrazine thrusters to provide attitude control and final orbit trim. The CZ-4 stage 3 is 1.92 m long, has a body diameter of 2.9 m and contains 14,150 kg of propellant, nitrogen tetroxide (oxidiser) and UDMH (fuel). The power plant is a pair of gimballed YF-40 engines that have a single burn time of 320 seconds. Two glass fibre payload fairings are available: 'A which is 4.91 m long and 3.0 m in diameter, giving a payload envelope of 3.0 × 2.4 m, and 'B' which is 8.48 m long and 3.35 m in diameter, giving a payload envelope of 6.5 × 3.0 m. The payload section can carry 1,500 kg into a sun-synchronous orbit at 900 km altitude, or a 4,000 kg payload into LEO.

A Chinese CZ-3B satellite launch vehicle beside its launch tower (China Great Wall Industry Corporation) 0022184

In 1994, preliminary details were released of a CZ-4B. which has an uprated stage 3. The first launch took place in June 1999, with a second launch in October 1999. CZ-4B has a length of 43.08 m and weighs 254,400 kg at launch; otherwise it is similar to CZ-4A. The improved stage 3 is 6.24 m long, has a diameter of 2.9 m and weighs 16,700 kg. It is believed that a pair of uprated YF-40 motors with a re-start capability are fitted, with a total burn time of 412 seconds and an average thrust of 101 kN.

CZ-5 (Long March-5)

A new series of Chinese SLV was announced in August 1999, known as CZ-5. It is reported that these will be three-stage SLV, with liquid hydrogen and liquid oxygen cryogenic fuel and oxidant. The first-stage body diameter will be 5.0 m, the second stage 3.25 m, and the third stage 2.25 m. These vehicles will have the capability to carry up to 20,000 kg into LEO and presumably will be used to assemble a manned space station at some time in the future. A first launch is not expected until 2005.

INDIA

ASLV

India's Augmented Satellite Launch Vehicle (ASLV), which is said to be comparable in performance to the US Scout, is based on the 17,000 kg SLV-3 with some uprating and the addition of a pair of strap-on Solid Rocket Boosters (SRB). Development began in the early 1980s and production of four vehicles was carried out by ISRO's Vikram Sarabhai Space Centre (VSSC) at Trivandrum.

The ASLV is a four-stage, solid propellant launch vehicle designed to carry payloads of 150 kg to 400 km. It is 23.6 m long, has a body diameter of 1.0 m and weighs 41,000 kg at launch. The ASLV strap-ons (AS-0) were derived from the earlier SLV-3's stage 1 and are filled with Hydroxy-Terminated-Poly-Butadiene (HTPB) solid propellant. They are 11 m long, have a body diameter of 1.0 m, weigh 8,628 kg at launch, and have a burn time of 47 seconds. Stage 1 (AS-I) was also derived from the SLV-3's stage 1, and is nested between the two strap-ons. It has an overall length of 10 m, a body diameter of 1.0 m and weighs 8,900 kg at launch. The motor, which ignites at 48 seconds after lift-off,

has a burn time of 48 seconds. Stage 2 (AS-2) is 6.4 m long, has a body diameter of 0.8 m, weighs 3,200 kg at launch, and has a motor burn time of 39 seconds. Stage 3 (AS-3) is 2.44 m long, has a body diameter of 0.81 m and weighs 1,080 kg at launch. The motor has a burn time of 46.7 seconds. Stage 4 (AS-4) consists of the motor, spin up system, payload separation system and a Kevlar 49 clam shell body casing with a cone-shaped nose. It has an overall length of 1.39 m, a body diameter of 1.0 m and weighs 320 kg without payload. The motor has a burn time of 33 seconds.

ASLV was first launched in 1987 and flew three more times before being retired in 1994, being followed by the Polar Satellite Launch Vehicle (PSLV).

PSLV

India's Polar Satellite Launch Vehicle (PSLV) was designed for placing 1,000 kg payloads in 900 km Sun-synchronous orbits. PSLV also offers growth potential to handle 450 kg into GTO and 3,000 kg to LEO (400 km). The VSSC is the lead centre for launchers and motor development, assisted by the SHAR centre at Sriharikota as the launch base and the Liquid Propulsion System Centre. The PSLV employs an unusual combination of liquid and solid stages, using liquid systems for stages 2 and 4 and clustering six ASLV SRB strap-ons around the solid first stage. The first launch (PSLV-D1) took place in September 1993 and carried an 846 kg payload, but was unsuccessful. By the end of 1997 there had been four launches, with two successful. A launch in May 1999 placed three satellites into 730 km orbits, a 1.050 kg Oceansat 1, plus two small satellites for South Korea and Germany. The sixth launch was made in April 2001, and was successful. A further five launches are planned up to 2004.

PSLV has an overall length of 44.2 m, a maximum body diameter of 3.2 m (5.1 m base circle with strap-ons) and weighs 294,000 kg at launch. The Polar Strap-On Motors (PSOM) are almost identical to the ASLV strap-ons but without Thrust Vector Control (TVC) secondary injection. They are 11 m long, have a body diameter of 1.0 m and weigh 8,628 kg at launch. Four are ignited on the pad, followed 25 seconds later by the remaining two. They have a burn time of 47 seconds and are jettisoned at 73 seconds (23 km) and 90 seconds (39 km) respectively. Stage 1 (PS-1) is a solid propellant motor nested in the six PSOMs. It has an overall length of 20.3 m, a body diameter of 2.8 m, and weighs 156,000 kg at launch. The motor, which contains 129,000 kg of HTPB solid propellant, has a burn time of 97 seconds. Stage 2 (PS-2/L37.5) has an overall length of 11.5 m, a body diameter of 2.8 m and a dry mass weight of 5,300 kg. It contains a liquid propellant motor and has two pairs of 15.3 kN solid propellant motors positioned on either side of the stage's lower skirt. These burn for 5.5 seconds at stage 1 separation. Also positioned on the skirt, equally spaced between the solid motors, are two pairs of 22.6 kN solid propellant retro motors that burn for 1.6 seconds. The engine is a Vikas open gas generator cycle engine (based on the French SEP Viking), which is gimballed for pitch and yaw control. The fuel tank contains 37,500 kg of UDMH and nitrogen tetroxide and the motor has a burn time of 150 seconds. Stage 3 (PS-3) is 3.54 m long, has a body diameter of 2.0 m and weighs 7,260 kg. It contains a solid propellant motor that has a burn time of 73 seconds. Pitch and yaw control is by nozzle flexure, controlled by two actuators. Roll control is by stage 4 thrusters. Stage 4 (PS-4/L2) is 2.65 m long, has a body diameter of 1.3 m and has a dry mass of 920 kg. It contains two ISRO 7.5 kN pressure-fed bipropellant engines, gimballed for three axis control. The motor, which uses 2,000 kg of MMH/nitrogen tetroxide, has a burn time of 425 seconds. Attitude control during main burn is by main engine gimballing and during coast by six 50N thrusters in two blocks. The payload bay is covered by a 4.5 m long cylindrical aluminium fairing topped with a nosecone. The total length of cover is 8.2 m long and has a body diameter of 3.2 m.

GSLV

The third generation of SLV for India is the Geostationary Satellite Launch Vehicle (GSLV), which has four liquid propellant strap-on boosters derived from the PSLV second stage and a cryogenic third stage. This provides a capability to place 2,500 kg payloads into GTO or 5.000 kg into LEO. The first version, GSLV-2, has a length of 50.9 m, a body diameter of 2.8 m, and a launch weight of 401,000 kg. The first stage has a solid propellant core and four liquid strap-on boosters each with a length of 19.7 m and a diameter of 2.1 m. The first stage has a weight of 129,000 kg. The core motor burns for 274 seconds, and the boosters burn for 158 seconds. The second stage has a liquid propellant Vikas motor, which burns for 150 seconds. The third stage uses a Russian KVD-1M cryogenic motor, and contains 12,000 kg of liquid hydrogen and liquid oxygen with a burn time of 800 seconds. The Russian motor is planned to be replaced with an Indian cryogenic motor, C-12, for the fourth or fifth launch. The C-12 motor was first ground run in February 2000. The first test launch of GSLV-2 was made in April 2001 from Sriharikota, and two further launches are planned. A GSLV-3 version is reported to be in development, with a liquid propellant first-stage core and two solid propellant strap-on boosters, with the C-12 motor in the third stage. GSLV-3 with have a length of 40.5 m, a launch weight of 610,000 kg, and the capability to place 4,000 kg into GTO.

INTERNATIONAL

Ariane Family

Following the collapse of the European Launcher Development Organisation (ELDO) and the failure of the Europa rocket based on the Blue Streak, France initiated the Ariane programme in 1972. Originally, the programme was funded by the European Space Agency (ESA) and managed by Centre National d'Etudes Spatiales (CNES) with industrial facilities provided by Aerospatiale (now EADS Launch Vehicles). However, in 1980, following four test and six production launches, the company Arianespace was established by CNES, with France, Germany and Italy as the principal nations plus 13 banks and 36 aerospace and electronics companies. After this, development was conducted by ESA via CNES, with EADS Launch Vehicles in overall control of the industry consortium.

The first in the family was Ariane 1, which was a three-stage liquid propellant vehicle designed to carry 1,850 kg payloads into GTO. Ariane 1 was 47.4 m long, 3.8 m in diameter and weighed 210,000 kg at launch. It was flown 11 times between 1979 and 1986. Ariane 2 and 3 were derived from Ariane 1, and enabled the payload to be increased to 2.1 75 and 2,700 kg respectively. These were identical in appearance except that Ariane 3 had the addition of two 10,000 kg strapon solid propellant boosters. Ariane 2 and 3 were three-stage liquid–propelled launchers with an overall length of 49.0 m, a maximum body diameter of 3.8 m and weighed 237,000 kg at launch. Ariane 2 was first launched in May 1986 and flew five more times before being retired in 1989. The first Ariane 3 was launched in August 1984 and flew 10 more times, the last flight being in July 1989. The development of a larger lift Ariane variant to become the standard vehicle through the mid-1990s began in 1982 and resulted in Ariane 4, which was first launched in June 1988.

Six variants of Ariane 4 were developed: Ariane 40 with no strap-ons; Ariane 42P with two solid propellant strap-ons; Ariane 44P with four solid propellant strap-ons; Ariane 42L with two liquid propellant strap-ons; Ariane 44LP with two solid and two liquid propellant strap-ons; and Ariane 44L with four liquid propellant strap-ons. The basic Ariane 40 is a three-stage liquid propellant launch vehicle designed to carry, with the aid of various strap-on boosters, 1,900 to 4,700 kg payloads into GTO for apogee kick motor into GEO. It has an overall length of 56.35 to 60.13 m (depending on fairing and payload), a maximum body diameter of 3.80 m and weighs between 245,000 kg (A40) and 484,000 kg (A44L) at launch. The Ariane 4's PAP (Propulseur *d'Appoint* Poudre) strap-ons are stretched versions of those used on Ariane 3 and are carried on the Ariane 42P, 44P and 44LP variants. They are 12.0 m long, have a body diameter of 1.0 m, contain 9.500 kg of CTPB 1613 solid propellant, weigh 12,660 kg each at launch, and have a burn time of 332 seconds. The Ariane 4's PAL (Propulseur *d'Appoint Liquide)* strap-ons are comparable in size and performance to stage 2 and are carried on the Ariane 42L, 44LP and 44L variants. They are 18.6 m long, have a body diameter of 2.2 m and have a dry weight of 4,550 kg. Each PAL contains nitrogen tetroxide oxidiser in a forward tank and UH25 fuel in an aft tank. The engine, which is a single SEP Viking 6 canted at a fixed 10". has a burn time of 142 seconds, igniting with the main engines three to four seconds before launch. Stage 1 is a stretched Ariane 3 stage 1 and is designated L-220. It is 28.4 m long including a 3.3 m tapered interstage, has a body diameter of 3.80 m and a dry weight of 17,500 kg. It contains 167,000 kg of liquid propellant, nitrogen

tetroxide oxidiser, in the forward tank and UH25 fuel in the aft tank. The power plant is an SEP Viking 5 engine, with four gimballed exit nozzles for steering, that has a burn time of 150 seconds. Stage 2 is a structurally stiffened Ariane 3 stage 2, with the designation L-33. It is 11.6 m long, has a body diameter of 2.6 m and a dry weight of 3,400 kg. It contains 34,600 kg of liquid propellant nitrogen tetroxide oxidiser in a forward tank and UH25 fuel in a rear tank. The engine is a single SEP Viking 4, gimballed for pitch and yaw control with a burn time of 125 seconds. Stage 3, which is essentially a structurally stiffened Ariane 3 stage 3, is produced in three variants designated H10, H10+ and H10-3. These are 10.7, 11.0 and 11.0 m respectively, have a body diameter of 2.6 m and a dry weight of 1,200, 1,240 and 1,240 kg respectively. They contain 10,800, 11,140 or 11,860 kg of liquid oxygen oxidiser and liquid hydrogen fuel. The engine is a single cryogenic SEP HM-7B. gimballed for pitch and yaw control with a burn time of 720, 750 or 780 seconds depending on variant.

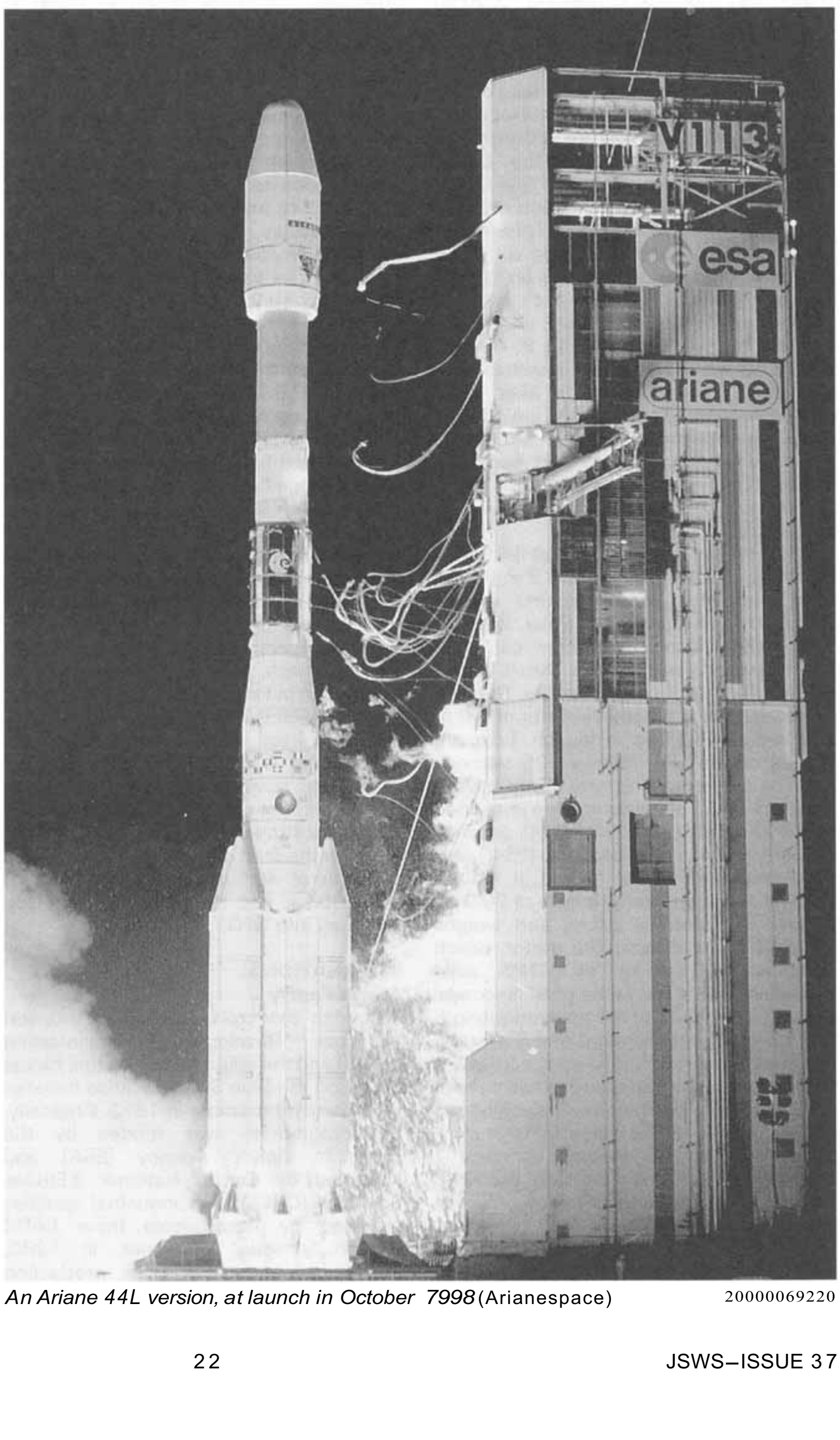
Ariane 4 has the choice of three two-piece aluminium alloy honeycomb payload/fairings/carriers: Type 01, which is 8.6 m long, has a capacity of 60 m^3 and weighs 740 kg; Type 02 is 9.6 m long, with a capacity of 70 m^3, weighing 800 kg; and Type 03, 10.1 m long with a capacity of 86 m^3. The fairing halves are separated by pyrotechnic line charge and piston at about 285 seconds during stage 2's burn.

A total of 116 launches have been ordered for Ariane 4, and are expected to take place up to December 2003. The June 2001 flight was the 62nd consecutive successful launch for Ariane 4. There are not expected to be any launches after 2003, as the Starsem consortium with EADS Launch Vehicles and the Russian TsSKB-Progress and Rosaviakosmos have agreed to market Soyuz launch vehicles as the medium-lift SLV from 2004.

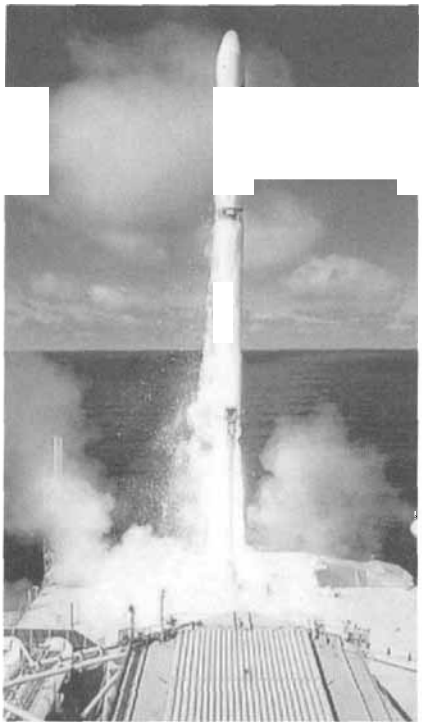
Ariane *5*

The Ariane 5 development programme was approved in 1987 to produce a vehicle offering 60 per cent additional GTO capacity and able to carry a manned spaceplane. Ariane 5 is a two-stage (plus two solid propellant strap-ons) liquid propellant launcher that is capable of carrying 6,700 kg into GTO, and 18,000 kg into **LEO.** It has an overall length of between 45.7 and 51.4 m, a body diameter of 5.4 m and weighs 746,000 kg at launch. The Ariane *5* P230 solid propellant strap-on boosters are parachute recoverable. They are 31.2 m long, have a body diameter of 3.0 m and weigh 277,000 kg at launch. Each P230 contains a single Europropulsion motor that burns 237,000 kg of propellant in 133 seconds. Stage 1, designation H155, is 30.7 m long, has a body diameter of 5.4 m and a dry weight of 12,600 kg. It contains 131,000 kg of liquid oxygen oxidiser in the forward tank and 25,600 kg of liquid hydrogen fuel in the aft tank. The engine is a single cryogenic SEP Vulcain, which has a large single gimballed nozzle for pitch and yaw control, and a burn time of 580

An Ariane 5 launch in October 1998 (Arianespace) 2000/0069221



An Ariane 44L version, at launch in October 7998 (Arianespace) 20000069220



The first launch of the Sea launch ***SLV in*** *March 1999*(Boeing) *200010062793*

seconds. Stage 2, designation L9-7, is 3.3 m long, has a body diameter of 4.0 m and a dry weight of 1,190 kg. The power plant is a DASA 27.5 kN storable propellant, pressure-fed motor, with a gimballed nozzle for pitch and yaw control with a burn time of 1.100 seconds in three burns. Ariane 5 has the choice of two standard 5.4 m diameter fairings to accommodate 4.57 m diameter payloads: short unit, 12.7 m long carrying up to 2,300 kg and long unit, 17 m long. The ogive fairing will jettison at about 191 seconds during stage 1 burn.

The first flight of Ariane 5 was made in 1996 but was unsuccessful, with the SLV destroyed by range safety staff shortly after launch. A successful second flight was made in October 1997. The third flight in October 1998 cleared the way for commercial operations, and the first commercial flight was made in December 1999. Five further flights were made up to July 2001, and a total of 34 flights have been ordered up to 2004. A re-startable cryogenic Vinci motor is being developed for the upper stage, and is expected to be operational by 2005. The Ariane 5ECA version has a length of 58.0 m, and a launch weight of 777,000 kg. This version will use a Vulcain 2 first-stage motor, and will be capable of placing 10,500 kg into GTO. Ariane 5ECB will have a length of 60.0 m, and a launch weight of 790,000 kg. This will have the capability to place 12,000 kg into GTO.

Sea Launch

The Sea Launch Company is an international consortium founded in April 1995 in response to growing market demand for a more affordable and convenient commercial satellite launching service. A rocket launched from the equator can take advantage of the earth's rotation speed to lift a 15 per cent heavier satellite to GTO, thus making the Sea Launch competitive in the 4,000 to 5,000 kg class. As the only potential launch sites on the equator were at sea, their answer was a floating stabilised launch pad in the shape of a converted oil rig. The company is owned by: Boeing Commercial Space Co, USA (40 per cent); RSC-Energia of Moscow, Russian Federation (25 per cent); Kvaerner Maritime AS of Oslo, Norway (20 per cent); and KB Yuzhnoye/PO Yuzhmash of Dnepropetrovsk, Ukraine (15 per cent). The prospects looked so good that in December 1995 Hughes Space & Communications Co placed a firm order for 10 launches beginning in 1998.

The Sea Launch satellite launching system consists of two vessels that form the marine infrastructure of the system, and the newly developed Russian Zenit 3SL three-stage rocket. The first of the vessels is an Assembly & Command Ship (ACS), which is an all-new, specially designed vessel that will serve as a floating rocket assembly factory while in port, and will provide crew and customer accommodation and mission control facilities. The ACS is 660 ft long, about 106 ft wide, with a draft displacement more than 34,000 tons and has a cruising range of 18,000 n miles. It provides accommodation for up to 240 personnel.The second vessel is the Launch Platform (LP), which is a former North Sea oil drilling platform. The LP is credited with being the largest semi-submersible self-propelled vessel in the world at 436 ft long and about 220 ft wide. The LP provides accommodation for 68 crew and spacecraft personnel including living, dining, medical, and recreation facilities. It is equipped with a large, environmentally controlled hangar for storage of the Sea Launch rocket during transit, and with mobile transporter/erector equipment used to roll out and erect the rocket in launch position prior to fuelling and launch. Special facilities onboard enable the storage of rocket fuels (kerosene and liquid oxygen) sufficient for each mission.

The Zenit 3SL is based on the Ukraine's Zenit 2 two-stage satellite launcher, with the addition of a Russian third stage derived from SL-12 Proton's stage four. Details of the Zenit 2 can be found in a separate Russian Federation entry. The three-stage Zenit 3SL has been specifically designed for use with the Sea Launch vessels, and to place loads up to 5,250 kg into GTO and 2,000 kg into GEO. It has an overall length of 59.8 m with a 11.39 m fairing, a principal body diameter of 3.9 m, and at launch weighs 470,000 kg with a 5,000 kg payload. Stage 1 is the same as that used in the Zenit 2/3, which has an overall length of 32.94 m, a body diameter of 3.9 m. and a dry weight of 20,080 kg. At launch it contains about 320,000 kg of liquid oxygen and kerosene. The engine is an NPO Energomash RD-171 with four gimballed exhaust nozzles for steering. This has a burn time of 144 seconds and a thrust of 7,259 kN at sea level. Stage 2 is also used in Zenit 2/3 and has an overall length of 11.5 m, a body diameter of 3.9 m, and a dry weight of 8,300 kg. At launch it contains about 80,600 kg of liquid oxygen and kerosene. The NPO Energomash RD-120 engine has a burn time of 300 seconds, a main thrust of 833.5 kN and is accompanied by four NPO Yuzhnoye vernier motors which can burn for up to 1,100 seconds. The Stage 3 has an overall length of 6.2 m, a body diameter of 3.7 m, a dry weight of 3,400 kg and at launch it contains about 14,600 kg of liquid oxygen and kerosene. This stage is powered by the newly developed Korolev bureau 11D58M restartable single chamber engine that has a burn time of 600 seconds over two burns and a thrust of 83 kN. The guidance system is the same as that used in the Zenit 2/3, which is inertial and receives navigational update just before launch via a laser optical receiver package mounted on the rocket side. This package is blown free at launch. There is also a telemetry system that provides information on 1,000 parameters during launch.

Prior to a launch the SLV stages and payload are delivered to the embarkation port. The stages are loaded into the ACS for assembling on the main deck (nine days). The ACS is capable of handling three vehicles in parallel. Meanwhile, the payload is processed and encapsulated in Boeing's two-piece composite fairing in nearby land facilities. The encapsulated unit is loaded on to the ACS for integration with Zenit (three days). The completed vehicle is then loaded into the Launch Platform's horizontal hangar (two days), where it remains for the 11-day journey to the launch site. There, the LP semi-submerges 22.5 m and Zenit is erected for launch. Fuelling begins at T-3 hours. Launch operations are controlled from the Launch Control Centre aboard the ACS, 5 km distant. Water deluge into the flame bucket protects the LP and reduces acoustic effects. The ACS provides tracking and telemetry reception for 410 seconds, then the Selena-M Russian tracking ship takes over until LEO parking, and finally Russian Altair satellites (Russian ground stations are also available) continue the task. Launch can occur with waves up to 2.5 m high.

In November 1998 it was reported that the Sea Launch programme had completed initial testing with the ACS and LP on the open ocean in preparation for a demonstration launch near the equator scheduled for March 1999. In early March 1999 the Sea Launch LP, now named ***Odyssey,*** left its home port for an equatorial position in the Pacific Ocean 2,253 km south of Hawaii to launch the first Zenit 3SL on 26 March. The launch actually took place on 27 March, successfully launching a demonstration satellite into GTO. The 4.700 kg demonstration payload was based on the Galaxy XI mission requirements.

In early 1997, there were 18 firm launch orders. The first commercial launch was made in March 1999, a second in October 1999, and by May 2001 there had been seven launches with six successful.

ISRAEL

Shavit/Next

The Shavit ('Comet') space launcher built by Israeli Aircraft Industries (IAI) was originally believed to have been derived from the two-stage Jericho 2 IRBM. first

launched in 1986 (for further details of Jericho 2 see separate entry). However, since the approval of the US government to market Shavit launchers commercially in the USA, it is understood that the Shavit and Jericho 2 programmes were quite separate developments. Development of the Shavit is thought to have begun in the early 1980s. The first launch of a Shavit vehicle with the Ofeq 1 test satellite took place in September 1988, and launch of a second Shavit carrying Ofeq 2 was made in April 1990. The Ofeq 3 satellite was launched in May 1995. However, there are unconfirmed reports that a possible fourth launch of Shavit failed between the Ofeq 2 and 3 launches. A successful launch was made in January 1998. In 1998, IAI teamed with Coleman Research Corporation in the USA to develop jointly a Shavit SLV version to launch payloads of under 900 kg into LEO. A LeoLink team has been formed with IAI, Coleman and EADS Astrium to operate two modified Shavit launchers, known as LK-1 and LK-2. The launches will be offered from Alcantara in Brazil, and LK-1 will use an improved upper stage. Two solid propellant strapon boosters may be used for LK-2.

Shavit is a three-stage, solid propellant launcher designed to carry 250 kg payloads into low earth orbit. It has an overall length of 18 m, a body diameter of 1.35 m and is reported to weigh 23,000 kg at launch. Stage 1 is 6.5 m long, and has a body diameter of 1.35 m. It contains a TAAS Israel Industries Ltd motor with an unspecified amount of HTPB solid propellant, which has a reported burn time of 1 minute. Attitude control is by four air vanes and four jet vanes which are jettisoned after the vertical launch phase. Stage 2 is 5.3 m long and has a body diameter of 1.35 m. Its motor is similar to staae 1 but with exaansion ratio increased for altitude performance This motor also has a burn time of I minute Attitude control in aitch and vaw ıs bv four Liquid-Injection Thrust Vector Control (LITVC) modules. Stage 3 is 2.1 m long, has a body diameter of 1.3 m and weighs 2,000 kg of which 1,800 kg is propellant. The motor is a Rafael AUS-51 'Marble' that has a burn time of 92 seconds. Attitude control is by spin stabilisation accomplished by Rafael's ST-200N thrusters.

In 1995, it was reported that IAI was working on the 'Next', which is an upgraded version of the Shavit. The work entails stretching stages 1 and 2 and adding a bipropellant stage 4. Development depends on commercial commitments, but there have been no reported launches. Israel used a Russian Start 1 SLV to launch a new recce satellite in December 2000, and it is assumed that the 'Next' development programme has been delayed.

JAPAN

Sounding Rockets

The Nissan Motor Company produces a range of solid propellant sounding rockets for the Japanese National Space Development Agency (NASDA), the Institute of Space and Astronautical Science (ISAS), the Japan Meteorological Agency (JMA) and the National Institute of Polar Research. The S series rockets are used widely for scientific observation and experiments One of the largest is the S-520 single-stage sounding rocket produced for the ISAS This rocket ıs capable of delivering 250 kg to a height of 400 km First launched in January 1980, 20 had been launched by the end of 1995 (17 from Kagoshima, Japan, and 3 from Andoya, Norway)

The S-520 is a single-stage rocket with a steel casing body that has four aluminium honeycomb tail fins with niobium/titanium alloy leading edges It has an overall length of 9 31 m, a principal body diameter of 0 524 m and weighs 2,285 kg at launch The motor ıs 6 05 m long, weighs 1.610 kg and contains polybutadiene composite propellant. It has an effective burn time of 28 7 seconds and an average thrust of 143 kN There ıs a slightly larger version designated SS-520 This ıs 9 5 m long, weighs 2,600 kg and can carry 137 kg to an altitude of 1,100 km

The ISAS is studying a three-stage version for orbiting ultra-small satellites This will be 9.82 m long, have a launch weight of 2,450 kg and be capable of delivering 17 kg satellites into a 200 × 1,000 km orbit

Another Nissan highly used single stage solid propellant rocket ıs the MT-135P This ıs a meteorological sounding rocket that is launched every week by the JMA's meteorological observation station to monitor the wind and temperature in the upper atmosphere. To date, more than 830 rockets of this type have been launched The MT-135P ıs 3 3 m long, weighs 70 kg and carries a 12 kg payload to an altitude of 60 km

H I and H2

The Japanese NASDA began developing the two-stage Delta-based N1 orbital launcher in 1970 under US licence, flying seven missions between 1975 and 1982. The 130 kg Geostationary Orbit (GEO) capability was increased to 350 kg for the eight N2s launched to 1987. In 1984, Japan's Space Activity Commission gave the go-ahead for the development of a large all-Japanese launcher designated H2 that would be capable of placing 2,000 kg in GEO and a small spaceplane in low earth orbit. However, work had already started on the H I in 1979 as an interim step. For the H1 launcher, the former N1/2's stage 1 with MB-3 engine was retained, but the cryogenic stage 2, inertial guidance and upper stages were all of Japanese design and manufacture.

The first launch of H I was made in August 1986, and a total of nine launches were made. The standard H I employed nine strap-on solid-propellant booster motors, but only six were used for light loads. The H I, which was retired from service in 1992, weighed 139,000 kg, and had a payload capacity of 1,100 kg.

Development of H2 began in 1985 and completed the transition to Japan's first fully indigenous launcher. The programme adopted solid propellant strap-ons and a cryogenic first stage, creating a capability comparable to that of Ariane 4 and Titan 3, but with a significantly lower launch mass due to the more advanced and lighter stages. The first H2 vehicle was successfully launched in February 1994,

A Japanese H2 ***SLV at launch*** (NASDA)

A S-520 sounding rocket on its launcher (Nissan) ***2000***/0062800

and by November 1999 there had been seven launches, with the last two failures, and the programme was terminated in December 1999. The H2 was a two-stage, liquid-propelled launcher designed to carry 10,000 kg into LEO, 4,000 kg into GTO and 2,000 kg into GEO. It had an overall length of 50 m, a body diameter of 4 m and at launch weighs 260,000 kg plus payload. In order to provide additional boost at launch the vehicle had two large strap-on Solid Rocket Booster (SRB) motors attached to either side of the first stage. These Nissan Motor Company SRBs were 23 m long, had a body diameter of 1.8 m and weighed about 70,000 kg each at launch. The burn time of these motors was 94 seconds and in the base of each was a flexible nozzle joint that provided thrust vector control to the launch vehicle during the initial boost phase up to the separation of the strap-on motors. Stage 1 was 28 m long, had a body diameter of 4 m and weighed 98,000 kg at launch. It contained 73,000 kg of liquid oxygen oxidiser in a forward tank and 13,000 kg of liquid hydrogen fuel in a rear tank. The engine was a single Mitsubishi LE-7 with a

large exit nozzle gimballed for pitch and yaw control after strap-on separation. Two auxiliary engines bled gaseous hydrogen from the LE-7 engine for roll control. Burn time for this motor was 346 seconds. Stage 2, which was an enlarged version of the H1's second stage, was 10.6 m long, had a body diameter of 4 m and weighed 19,700 kg at launch. It contained 2,800 kg of liquid hydrogen fuel in a forward tank and 13,900 kg of liquid oxygen oxidiser in a rear tank. The engine was a single Mitsubishi LE-5A with the exit nozzle gimballed for pitch and yaw control after stage 1 separation, and two IHI hydrazine thruster modules provided roll control during burn and three axis control during coast. Burn time for the motor was 610 seconds; there were two burns, 403 and 197 seconds for a typical GEO mission. The standard payload fairing attached to the front end of stage 2 had a cone-shaped rounded nose, was 12 m long, and had a body diameter of 4 m. This contained a 3.7 m envelope for single or dual payloads weighing up to 4,000 kg. A 5 × 12 m version was developed for Shuttle-type payloads (4.6 m). Separation of the clamshell halves was effected by a mild detonating fuze and springs when aerodynamic heating had fallen after about 220 seconds during stage 1 burn.

A lower-cost H2A family of SLVs was developed from 1995, and became the major programme following the termination of the H2 project in 1999. The first test flight was made in August 2001 from Tanegashima, and a second test is planned for 2002. The third flight is planned to be the first commercial payload. Four vehicle variants are planned, H2A202, H2A2022, H2A2024 and H2A212, each with different payload capabilities from 10,000 kg to LEO up to 15,000 kg to LEO, and with the capability to place payloads of up to 4,000 kg in GTO. Stages 1 and 2 of the H2A family will be the same. Stage 1 has a length of 37.2 m, a diameter of 4.0 m and a launch weight of 114,000 kg. The motor is a single Mitsubishi LE-7A. using liquid oxygen and liquid hydrogen, with 100,000 kg of fuel and oxidiser and a burn time of 390 seconds. Stage 2 is 9.2 m long, has a diameter of 4.0 m, and weighs 20,000 kg. The LE-5B motor uses 16,000 kg of liquid oxygen and liquid hydrogen, and has a burn time of 534 seconds. The overall length of each of the four SLVs is 53 m. H2A202 has two SRB-A solid rocket boost motors and weighs 289,000 kg at launch. H2A2022 has two SRB-A and two SSB solid boost motors, and weighs 319,000 kg at launch. H2A2024 has two SRB-A and four SSB solid boost motors, and weighs 349,000 kg at launch. H2A212 has *two* SRB-A solid boosters and a single LRB liquid boost motor, and weighs 407,000 kg at launch. The SRB-A motors are 15.2 m long, have a diameter of 2.5 m and weigh 76,500 kg. Each motor has 65,000 kg of solid propellant and a burn time of 100 seconds. The SSB motors are 14.9 m long, have a diameter of 1.0 m, and weigh 15,000 kg. Each motor has 13,000 kg of solid propellant and has a burn time of 60 seconds. The LRB motor is similar to the first stage but has two LE-7A combustion chambers. It is 36.7 m long, has a diameter of 4.0 m, and a weight of 117,000 kg. Each contains 99,000 kg of liquid oxygen and liquid hydrogen, and has a burn time of 202 seconds. Guidance for the H2A family is provided by a newly developed IMU using ring laser gyros and a control computer to eliminate the need for ground control. It is planned that there will be 10 commercial launches of the H2A family by 2005.

M-5

In 1987-88, ISAS began studies on a large successor to the M-3SII, capable of placing 2,200 kg in LEO and dispatching 550 kg to the moon. The vehicle, designated M-5, was approved during 1989 and a test launch was originally planned for 1993-94. A prototype M-5 stage 1 was successfully tested in June 1994. ISAS and Nissan also began studies in 1990 of an air-launched three-stage winged version, capable of carrying 1,270 kg into a 250 km orbit.

The M-5 is a three- or four-stage, solid propelled launch vehicle designed to carry payloads of 2,000 kg to 200 km, 1,200 kg to 500 km and 800 kg to GTO. The three-stage version has an overall length of 31.0 m, a body diameter of 2.5 m and at launch weighs 130,000 kg. Stage 1, designation M-14 is 13.65 m long, has a body diameter of 2.5 m, and weighs 82,500 kg at launch. It contains 72,000 kg of solid propellant and has a burn time of 47 seconds. Attitude control is by a movable nozzle, actuated by a gas generator. Stage 2, designation M-24, is attached to stage 1 by lattice work and incorporates an extending nozzle. It is 6.7 m long, has a body diameter of 2.5 m and weighs 34,300 kg at launch of which 31,000 kg is solid propellant. The motor has a burn time of 70 seconds. Attitude control during second stage burn time is by liquid injection TVC. Stage 3, designation M-34, also incorporates an extending nozzle. This stage is 3.55 m long, has a body diameter of 2.2 m and weighs 11,100 kg at launch. It contains 10,100 kg of solid propellant in a carbon fibre filament case, and has a burn time of 103 seconds. Attitude control is by electrically activated TVC. The payload accommodation is a honeycomb clam shell fairing that is 9 m long, has a body diameter of 2.5 m and weighs 715 kg.

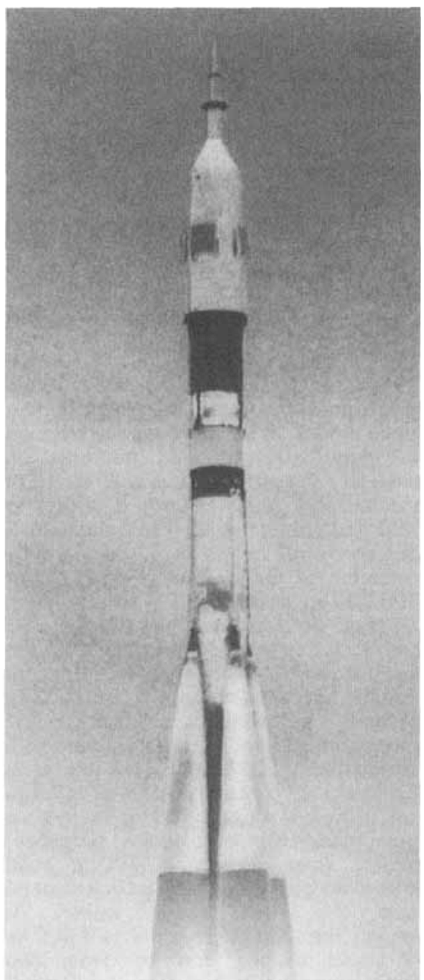
There were originally four annual missions scheduled for the M-5, but these have now been reduced. The first launch was made in February 1997, and a second launch was made in July 1998, to launch the Planet B probe to Mars. A launch in February 2000 failed.

RUSSIAN FEDERATION

SL-4/A-2 Soyuz

The first satellite was launched by the former USSR in May 1957 using a modified *SS-6* 'Sapwood' ICBM. Further details of this missile can be found in the Obsolete Offensive Weapons section. This launcher was known as SL-3/A-1 Vostock, and around 1,525 Vostock were launched, with a success rate of 94 per cent. SL-4/A-2 Soyuz was first launched in 1963. and was also based on the SS-6 'Sapwood'. The estimated number of SL-4/A-2 Soyuz launches to the end of 2001 was 1,115, with a success rate of 97 per cent. There have been 160 flights since 1990, with only two failures

SL-4 is a two-stage liquid propellant launcher, boost assisted by four liquid propellant boosters It was designed to carry 6,900 kg payloads into LEO The overall shape of the launcher before launch is similar to SL-3, with the exception of its longer length and the distinctive tall, slim Soyuz-TM escape tower on the manned version. SL-4 has an overall length of 49.5 m (manned version). 45.2 m (unmanned version), a core body diameter of 3 0 m and weighs about 310,000 kg at launch The SL-4 strap-on boosters are as for SL-3, but have a 118 second burn time for commercial launches. Stage 1 is the same as SL-3 but has a 285 second burn time, suggesting an 86,000 kg fuel load Stage 2, designated Block I, is 8.1 m long, has a body diameter of 2 66 m and a dry weight of 2,400 kg. At launch it contains 23,000 kg of liquid oxygen and kerosene, which is ignited at separation, and has a burn time of 245 seconds The engine is an RD-0110 from the Kosberg bureau (now KB Khimautomatik) incorporating four fixed chambers and four verniers for steering. The unmanned clam shell payload fairing has a coneshaped rounded nose, is 10.1 m long, and has a payload envelope of 9 × 2.65 m diameter. Separation of the fairing halves takes place at between 152 and 171 seconds after launch depending on ascent angle.



A manned Russian SL-4 *Soyuz* ***launch vehicle*** (Soviet Military Power)

The SL-4/A-2 Soyuz has been the most used Russian launcher, typically with 15 to 20 launches per year at its peak activity. Glavcosmos began commercial marketing of the SL-4 in 1986, but there have been no reported sales. In 1993, the Russian Space Agency announced that it was funding upgrades of the launcher to create the 'Rus' model in 1997, principally for polar missions from Plesetsk. The name has now been changed, in 1996, to Soyuz 2. This will increase the payload to LEO to 8,250 kg, which will be achieved by upgrading the two core stages, new strap-on boosters, and improved avionics. Soyuz 2 will have two or three stages, a total launch weight of 307,000 kg (two-stage) or 311,000 kg (three-stage), and a length of 39.8 m (two-stage) or 44.0 m (three-stage). In 1996 a Starsem Consortium was created by the Russian Space Agency (Rosaviakosmos), TsSKB-Progress, Samara Space Centre, and EADS Launch Vehicles to develop and market commercial launches using Soyuz 2. Launches will be made from Plesetsk and Baikonur, and there is a proposal to use Kourou in French Guiana. It is planned that Starsem will market both Soyuz and Ariane 5 space launch vehicles together, to cover a complete range of payloads. New upper stages have been developed for Soyuz vehicles, including Fregat and Ikar, and Ikar has a re-startable liquid motor and a dispenser system for launching multiple satellites.

SL-6 Molniya
The SL-6 is the most powerful of the SS-6 'Sapwood'-based space launchers. It was designed by TsSKB-Progress for planetary missions, but is now principally used for placing Russian Cosmos early warning and Molniya communication satellites into highly concentric Earth orbits. SL-6 can be launched from Plesetsk or Baikonur. SL-6 was first launched in 1960, which was an unsuccessful Mars probe. The first successful launch took place in 1961 (Venera Venus Probe) and at the end of 1997 this launcher had flown an estimated 290 times. SL-6 is a three-stage liquid propellant launcher, boost assisted by four liquid propellant boosters. It was designed to carry 1,000 kg plus payloads on planetary missions. The overall shape of the launcher before launch is similar to SL-3 and unmanned SL-4 launchers. SL-6 has an overall length of 42.0 m, a body diameter of 3.0 m and weighs about 306,000 kg at launch. The four strap-on SRBs are the same as those used on SL-3 and SL-4, and the first two stages are the same as the first two stages of SL-4, except that the burn time of stage 2 is about 230 seconds, indicating a 21,000 kg fuel propellant loading. The additional stage 3, designated 11D33, Block L family, is 2.64 m long, has a body diameter of 2.4 m and a dry weight of 1,100 kg. As well as the main Korolev liquid propellant motor, stage 3 has a 700 kg solid propellant booster motor that is jettisoned after the main engine ignites. At launch, the third stage contains 5,500 kg of liquid oxygen and kerosene, and has a burn time of 200 seconds. Stage 3 and the payload bay are covered by a 7.9 × 2.7 m fairing with a cone-shaped nose. This provides a payload envelope of 3.7 × 2.65 m.

SL-8 Cosmos
The SL-8 originated as the SS-5 'Skean' IRBM, which was developed in the 1950s and entered operational service in 1961 (for further details of SS-5 see separate entry in Obsolete Offensive Weapons). The silo-launched SS-5 was developed into a space launch vehicle by NPO PM and the NPO Yuzhnoye (Ukriane), and was first launched in August 1964. Recent reports from Russia suggest that the initial SLV was known as SL-7 Cosmos, and the later SL-8 version was known as Intercosmos. It is believed that a total of some 735 launches have been made with a vehicle success rate of around 97 per cent.

SL-8 is a two-stage liquid propellant launcher, designed primarily to carry 1,000 kg payloads of military stores into 800 to 1,500 km circular orbits; it has also been used to carry 1,500 kg to 180 km. It has an overall length of 32.4 m, a body diameter of 2.4 m and weighs 109,000 kg at launch. Stage 1 is 22.5 m long, has a body diameter of 2.4 m and a dry weight of 5,300 kg. At its base, there are four delta-shaped stabilisation fins which were not on the original SS-5 'Skean'. At launch the stage 1 contains 82,000 kg of storable liquid propellant and has a burn time of 130 seconds. The engine is an RD-216 from the Glushko bureau (now NPO Energomash). This has four fixed exhaust chambers into which are inserted a graphite vane for steering control. Stage 2 has two unusual externally mounted, rectangular side tanks for longer missions, using small thrusters for the climb to the required altitude. The overall length of stage 2 (including nozzle) is 6.6 m and the external tanks run the full length of the 4.4 m body casing. The body diameter is 2.4 m (3.2 m across opposite sided fuel tanks), and the stage has a dry weight of 1,400 kg. At launch it contains 19,000 kg of storable liquid propellant. The main engine is a KB Khimmach 11D49, having a fixed single chamber and four steering verniers. The main motor has a burn time of 330 seconds and the small verniers burn for 500 seconds. The clam shell payload fairing has a cone-shaped rounded nose, is 5.7 m long, and has a body diameter of 2.4 m, giving a payload envelope of 12.6 m^3. Separation of the fairing halves takes place at around 75 km from launch and the payload is separated within 20 seconds of stage 2 shutdown.

The SL-8/C-1 Cosmos is supported by PO Polyot in Omsk. An improved version is reported to have been developed, increasing the performance by 15 to 20 per cent. SL-8 is normally launched from Baikonur, but the first launch from Kapustin Yar was made in April 1999.

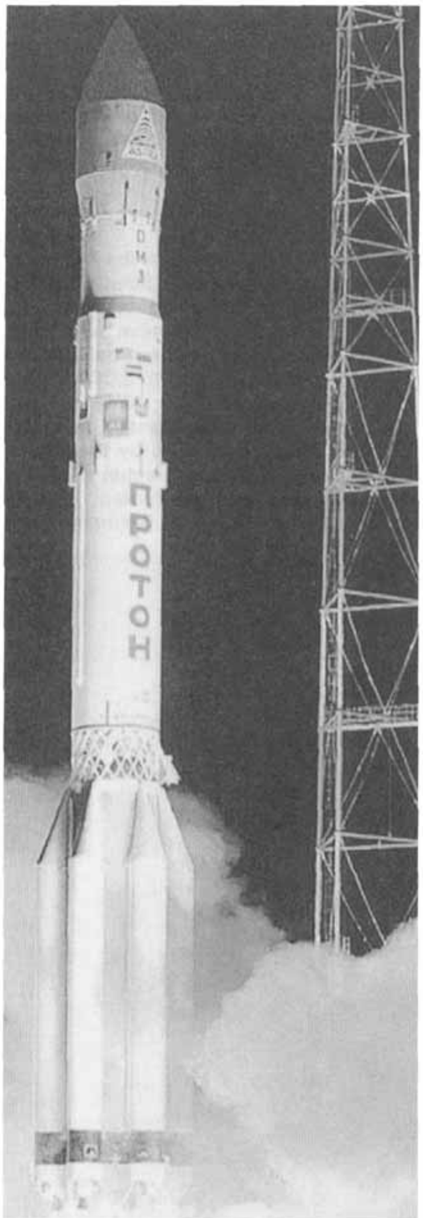
SL-11/F-1 Tsyklon 2
The SL-11/F-1 launcher was derived from the SS-9 'Scarp' ICBM developed by the Yangel bureau (now NPO Yuzhnoye, Ukraine) in the 1950s and first tested in 1963. Further details of the SS-9 can be found in the Obsolete Offensive Weapons section. The two-stage SL-11 was introduced in 1966 with its first operational flight being carried out in September that year. It was also originally used in the Fractional Orbit Bombardment System (FOBS) and satellite interceptor programmes. But, in recent years, the SL-11 has operated exclusively as an ocean surveillance satellite carrier. The estimated number of SL-11/F-1 launches to the end of 1994 was 128 with a success rate of 94 per cent. In 1977, a third stage was added to create the SL-14/F-2 Tsyklon 3, which was developed to take over from the SL-3/A-1 Vostok launcher.

SL-11 is a two-stage liquid propellant launcher, designed to carry 3,000 kg payloads into LEO. It has an overall length of 35.0 m, a body diameter of 3.0 m and weighs 179,000 kg, excluding payload, at launch. Stage 1 is 19.4 m long and has a body diameter of 3.0 m. It contains 122,000 kg of liquid nitrogen tetroxide oxidiser and UDMH fuel. The engine, which has a burn time of 120 seconds, is an RD-218 from the Glushko bureau (now NPO Energomash). This has an unusual, distinctive arrangement of six main nozzles in the centre and four gimballed verniers on the diameter for steering. These verniers are faired into the outer skin with blunt squarish sub fins. Stage 2 is 11.0 m long, and has a body diameter of 3.0 m. At launch it contains 51,000 kg of nitrogen tetroxide oxidiser and UDMH fuel, which gives the stage a burn time of 158 seconds.

The engine is believed to be an RD-219 also from the Glushko bureau with two fixed chambers and possibly four peripheral verniers for steering. The payload fairing has a cone-shaped rounded nose, is 10 m long, and has a body diameter of 2.7 m, giving a payload volume of 19 m^3.

SL-12 Proton K/KM
The Proton SLV developed by the Chelomei OKB-52 and introduced in 1965, was a two-stage, liquid propellant vehicle capable of delivering 12,200 kg payloads into LEO. It had the distinction of being the first Russian launcher not derived from a military vehicle, although the design did begin in 1962 as the UR500 ICBM. The two-stage version was rapidly superseded by three- and four-stage versions. Confusingly, the Russians refer to both as the Proton-K. This is done because the basic vehicle is considered to be the 44.3 m length (plus payload) Khrunichev three-stage Proton-K, and if required a fourth stage can be added for missions beyond LEO. The Proton's original fourth-stage started life as the fifth-stage of the N-1 manned lunar vehicle developed in the late 1960s. Two basic types are currently flown on the Proton-K: the Block D family and the Block DM family. Proton-K (four-stage) was first launched in March 1967 and, by the end of 1996, had flown 212 times with a reported success rate of 86 per cent. The Proton-K (three-stage) was first launched in November 1968 and by the end of 1996 had flown 27 times.

The Proton-K (four-stage) is a four-stage liquid propellant launcher, designed for planetary missions and to carry 2,100 kg payloads into LEO. It has an overall length of 57.0 m, a body diameter of 7.4 m (first stage), 4 m (upper stages) and weighs 690,000 kg at launch. Stage 1 is unusual



A Russian SL-12 Proton Block DM at launch (ILS) **200010062801**

in that its six engines (each with a diameter of 1.6 m) are arranged around the 4.1 m diameter core for its full length. It is 21.1 m long, has a body diameter of 7.4 m and a dry weight of 31,000 kg. The centre core contains about 420,000 kg of liquid nitrogen tetroxide oxidiser, whilst the UDMH fuel is carried in side tanks. The six engines, which have a burn time of 130 seconds, are RD-253 from the Glushko bureau (now NPO Energomash). Stage 2 is 14.56 m long, has a principal body diameter of 4.15 m and a dry weight of 11,700 kg. At launch it contains 156,000 kg of nitrogen tetroxide oxidiser and UDMH fuel, which gives the stage a burn time of up to 300 seconds. The motor assembly, which has a thrust of 2,376 kN, consists of three RD-0210 engines and one RD-0211, all gimballed for steering and developed by KB Khimautomatiki. Stage 3 is designed to eject stage four or the payload (in the case of a three-stage launch) into a 200 km circular, 51.6 degree parking orbit about 10 minutes after launch. It is 6.52 m long, has a principal body diameter of 4.15 m and a dry weight of 4,185 kg. At launch it contains 46,600 kg of nitrogen tetroxide oxidiser and UDMH fuel. The engine, which has a burn time of 250 seconds, is a single fixed RD-0212 version of RD-0210 with four gimballed verniers for steering.

Since 1967 there have been several versions of stage 4: Block D (1967), Block D1 (1973). Block D-2 (1988). Block DM (1974). Block DM-2 (1982). Block DM-2M (1994), Block DM-3 (1996) and possibly a Block DM-4 in 1997. These are manufactured by RKK Energia and the control system is by NPO AP. The overall length and dry weight of Block D/DM stage 4s varies between 5.36 and 6.21 m and 2,500 kg and 3,400 kg depending on type. They weigh between 17,300 kg and 18,460 kg at launch; all have the same body diameter of 3.7 m, and use liquid oxygen oxidiser and kerosene or syntin fuel. The common engine is a Korolev bureau 58/58M restartable single chamber engine that has a burn time of 600 seconds over two burns. There is a wide range of payload fairings available all with cone-shaped noses.

In late 1993 the Russian Space Agency announced that it was funding improvements to both Proton K and Soyuz. Proton K's stage 1 engines were upgraded (as they were in 1986 and possibly in 1991). Zenit's avionics were adopted, a 5 m diameter payload fairing was added, and the interstages strengthened to cope with the heavier loads. These improvements provide the capability to lift 22,300 kg to LEO, and 3,000 kg to GTO. The Proton KM (M means 'Modernised') has been developed to place 5,000 kg in GTO using Khrunichey's own Breeze-M (adapted from Rokot) re-startable liquid engine, and a new Salyut KVRB cryogenic upper stage. A new stage 2 has also been proposed, powered by a single RD-0120 LOX/LH_2 engine. Addition of NPO Lavotchkids Fregat as a fifth stage under the existing fairing has been studied to increase Proton K GEO capacity to 3,300 kg. The first Proton KM was launched in April 2001.

The Proton KM Breeze-M Stage 4 consists of the newly developed Breeze upper stage used in the Rokot launcher system. Breeze itself is 3.38 m long and has a maximum body diameter of 2.28 m. It contains 3,500 kg of UDMH fuel and nitrogen tetroxide oxidiser. The main engine is believed to be a restartable KTDU-425. which has a specific impulse of 325 seconds, a total thrust of 20 kN and a total burn time of 564 seconds (max six burns). The main engine is assisted by four fixed vernier engines with a burn time of 275 seconds and a thrust of 3.9 kN. In addition, Breeze carries 12 attitude control thrusters, each with a thrust of 0.13 kN and a specific impulse of 270 seconds. The Proton KM cryogenic Stage 4 has an overall length of 8.6 m, a principal body diameter of 4.0 m and a dry weight of 3,400 kg. It contains 19,000 kg of liquid hydrogen fuel and nitrogen tetroxide oxidiser. The engine is a single chamber cryogenic KVD-1M (with two verniers) capable of five burns (total 450 seconds) and 7.5 hours coast.

Following the merger of Lockheed and Martin Marietta in 1995, International Launch Services (ILS) was created to handle the joint commercial marketing of Proton and Atlas for the Lockheed-Khrunichev-Energia venture and Lockheed Martin Commercial Launch Services (LMCLS). Lockheed-Khrunichev-Energia International Inc (LKE) was formed in early 1993 as a joint venture to market Russia's Proton launch vehicle and associated launch services. ILS services cover spacecraft integration, Proton and Atlas supply, mission management, insurance brokering. launch site support, post-mission support and customer support. In 1999 ILS proposed to develop the Angara SLV family, as a replacement for the SL-12 Proton. There are planned to be modular light-, medium- and heavy-lift SLVs, designated Angara 1/2/3/4/5, with launch weights from 145,000 to 790,000 kg.

SL-14/F2 Tsyklon 3

The SL-14/F2 launcher is a three-stage version of the SL-11, and was developed in the early 1970s to take over from the SL-3/A-1 Vostok launcher. It was first launched in 1977 and the number of operational flights until the end of 1997 was 116, with an estimated success rate of 96 per cent. The F2 Tsyklon 3 (Cyclone) has mainly been used to launch the EORSAT and RORSAT ocean reconnaissance satellites. SL-14 has the capability to carry payloads of 3,600 kg to 200 km, 2,500 kg to 1,000 km, 1,700 kg to 2,000 km and 1,300 kg to 3,000 km. It has an overall length of 39.3 m, a body diameter of 3.0 m and weighs 185,500 kg excluding payload at launch. Stages 1 and 2 are the same as SL-11 (see above), except stage 2 is believed to have an uprated motor that is possibly an RD-219 derivative.

Stage 3, designated S5M, is 2.58 m long, has a body diameter of 2.25 m, and contains 2,800 kg of nitrogen tetroxide oxidiser and UDMH fuel. The engine, which has a burn time of 118 seconds, is an NPO Yuzhnoye 11D25 that gives three axis control by eight fixed nozzles. The payload fairing has a cone-shaped rounded nose, is 10 m long, has a body diameter of 2.7 m, and covers stage 3, at the same time providing a payload volume of 19 m^3.

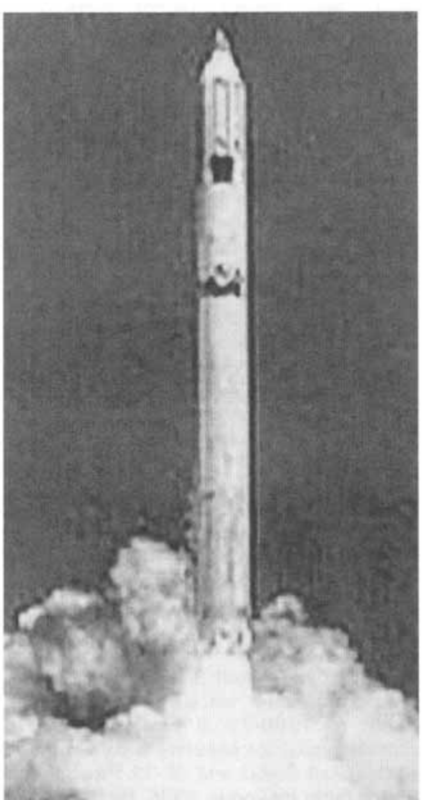
In 1999 a Tsyklon 4 launch vehicle was announced, to be developed by Yuzhnoye (Ukraine) and FiatAvio (Italy). This version will be capable of carrying a payload of 4,500 kg to LEO, and 1,700 kg to GTO. There will be three liquid propellant stages and the SLV will weigh 193,000 kg at launch. The first stage will have 120,600 kg of nitrogen tetroxide and UDMH, the second stage 49,000 kg and the third stage 9,000 kg of the same propellants.

SL-16/J-1 Zenit 2

The SL-16/J-1 Zenit 2 was the first new Russian launcher since the unsuccessful SL-15 of 1969-72. It was designed to provide a payload capacity between those of the SL-4 Soyuz and SL-12 Proton, and began flight testing in 1985. By the end of 1997, 27 operational flights had been carried out, with a reported success rate of 83 per cent. Zenit 2 has been used to

launch Russian Tselina-2 ELINT satellites, and is expected to be used for future photo-reconnaissance satellites. The two-stage. liquid propellant SL-16 Zenit 2 has the capability to carry payloads of 13,740 kg to 200 km. It has an overall length of 57.0 m, a body diameter of 3.9 m and weighs 450,000 kg excluding payload at launch. Stage 1 has an overall length of 32.0 m, a body diameter of 3.9 m, and a dry weight of 20,000 kg. At launch it contains about 320,000 kg of liquid oxygen and kerosene. The engine, which has a burn time of 144 seconds, is an NPO Energomash RD-171 with four gimballed exhaust nozzles for steering. Stage 2 has an overall length of 10.8 m, a body diameter of 3.9 m, and a dry weight of 8,300 kg. At launch it contains about 80,600 kg of liquid oxygen and kerosene. The NPO Energomash RD-120 engine has a burn time of 300 seconds and is accompanied by four NPO Yuzhnoye verniers that burn for up to 1,100 seconds. The payload fairing has a cone-shaped pointed nose, is 13.65 m long and has a body diameter of 3.9 m. An 11.0 m long version is available.

The introduction of a liquid-propellant stage 3 derived from SL-12 Proton's stage 4 (see above) is planned. This launcher, called Zenit 3, will have an overall length of 61.4 m, a body diameter of 3.9 m and a dry weight of 466,000 kg. It will be capable of carrying 3,820 kg payloads into GTO and 600 kg into GEO. Stages 1 and 2 are the same as those used for Zenit 2; stage 3 is 6.2 m long, has a diameter of 3.7 m and weighs 18,200 kg. The third stage has a restartable Korolev 58M motor using nitrogen tetroxide and UDMH, with a total burn time of 600 seconds.



A SL-16 Zenit 2 SLV at ***launch*** (Yuzhnoye)
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A further version, known as Zenit 3SL, is being used by Sea Launch, a commercial organisation including Boeing (USA), Kvaerner (Norway), RSC-Energia (Russian Federation) and Yuzhnoye and Yuzmash (Ukraine). This is described in a separate entry.

Zenit 4 has been proposed with a fourth stage added to give the capability to place 1,700 kg into GEO

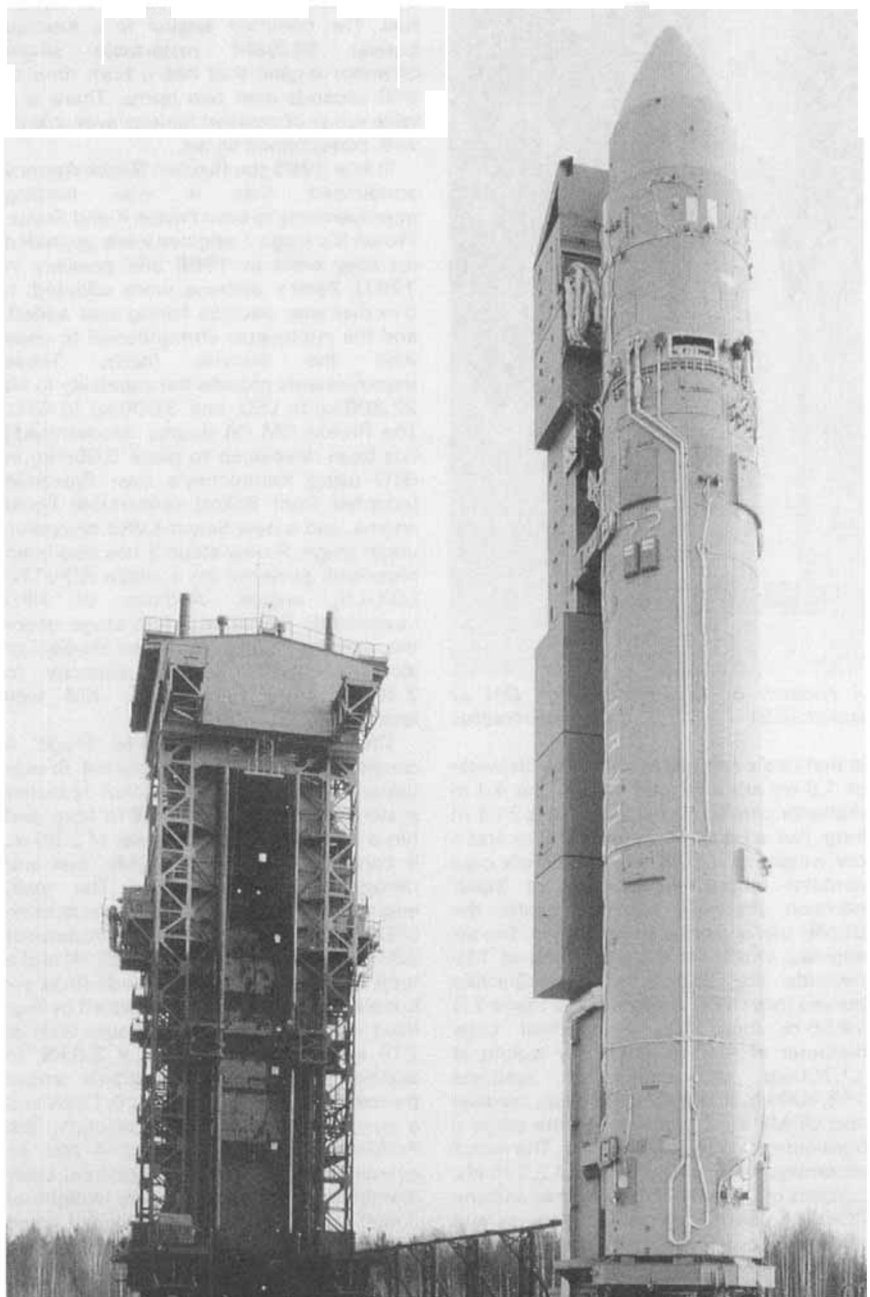
Start 1/2

The two Start SLVs have been developed by the Kompleks-MIT NPO based upon the SS-25 'Sickle' ICBM design. Start 1 is a five-stage solid-propellant rocket with a launch weight of 47,000 kg, a length of 22.7 m and capable of placing 350 kg into LEO The first launch was made in 1993, and the second in 1997. This latter launch was the first made from the new Russian cosmodrome located at Svobodny, in Siberia and close to the Chinese border Two further launches were made in December 2000 and February 2001

Start 2 is a six-stage solid-propellant rocket with a launch weight of 60,000 kg, a length of 28.9 m, and capable of placing up to 600 kg in LEO. The first launch test in 1995 was unsuccessful.

Rokot

The Rokot SLV is based upon the two-stage liquid propellant SS-19 'Stiletto' ICBM, some of which are being taken out of service. Together with a new third stage called Breeze, Rokot has been designed to place space vehicles of up to 3,000 kg into LEO The first launch was made in 1990 and a total of three successful launches had been made from silos by the end of 1997 The SLV is manufactured by the Krunichev NPO who formed a joint company with DASA of Germany (now



EuRockot SLV launch preparation at Plesetsk in May 2000 (EuRockot) ***2002*** 0126682

EADS Astrium), called EuRockot. The Rokot will be marketed by Starsem as a light-lift SLV. Although the test launches were made from silos at the Tyuratam test centre, EuRockot have upgraded the launch facilities at the Plesetsk Cosmodrome and the first commercial launch was made from Plesetsk in May 2000. In addition, a silo-based launch is planned from the Svobodny cosmodrome in Siberia.

The Rokot SLV is a three-stage liquid propellant launcher that has an overall length of 28.5m, a diameter of 2.5 m, and weighs 107,000 kg at launch. Stage 1 is 17.2 m long, has a diameter of 2.5 m, and carries 85,000 kg of UDMH and nitrogen tetroxide. This stage is powered by four RD-0233 engines that have a burn time of 120 seconds. It also carries four retro-rockets for separation of the second stage. Stage 2 is 3.9 m long, has a diameter of 2.5 m, and carries 15,000 kg of UDMH and nitrogen tetroxide. This stage is powered by a RD-0235 main engine with a burn time of 158 seconds, and RD-0236 vernier motors with a burn time of 183 seconds. The newly designed Breeze-KM third stage is 3.38 m long, has a diameter of 2.28 m and carries 3,500 kg of nitrogen tetroxide and UDMH. The main motor is believed to be a re-startable KTDU-425, which has a thrust of 20 kN and a total burn time of 564 seconds with a maximum of six starts.

UNITED STATES OF AMERICA

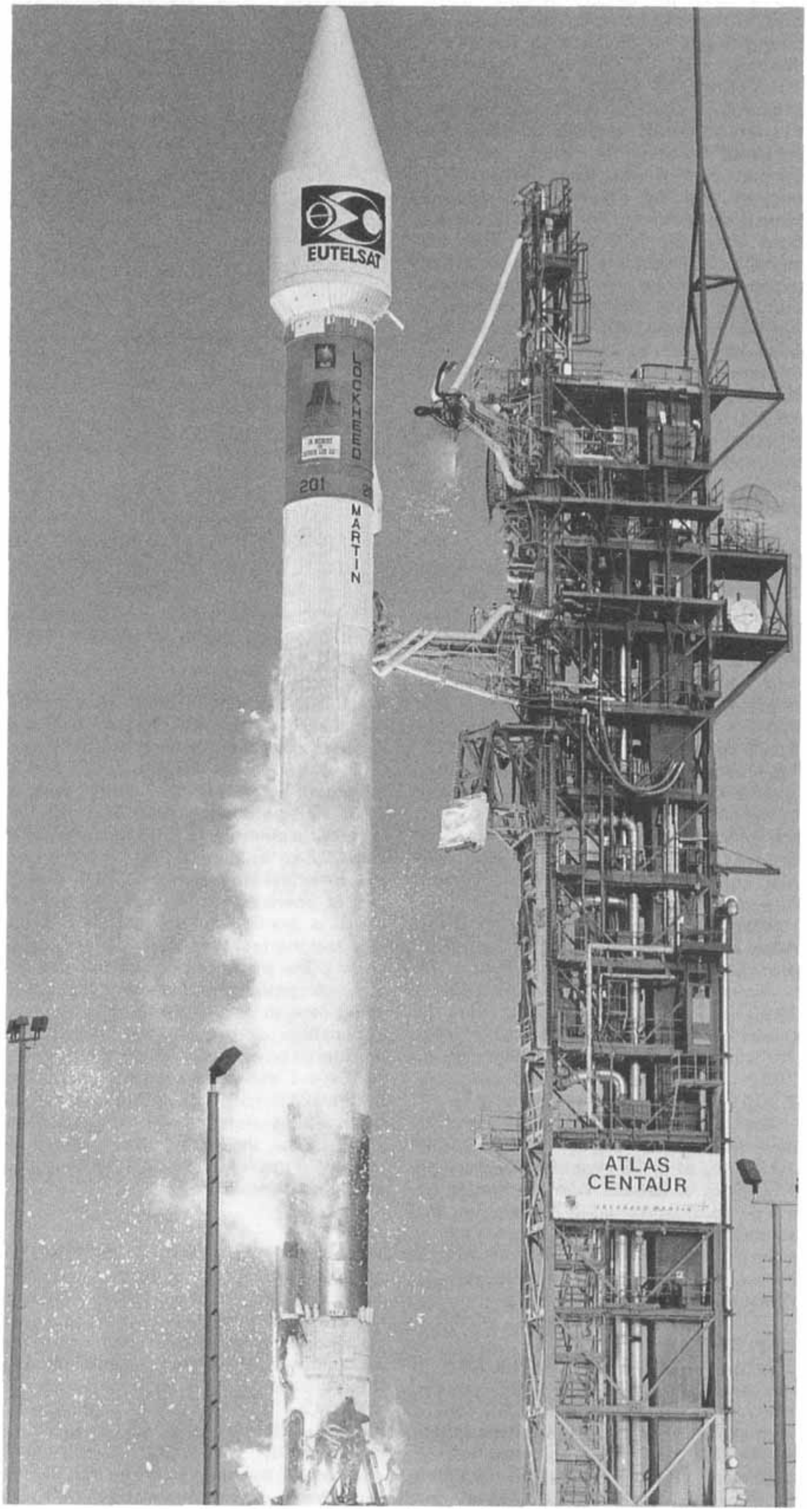
Atlas 1

The MGM-16 Atlas was developed as the first US ICBM, becoming operational in 1959. When retired from service around 1965, some 125 missiles of various marks were deployed throughout the USA. Most of these were converted to form the start of the Atlas SLV-3 space launch vehicle programme. More than 500 of these have been launched, responsible for orbiting the first US astronaut and dispatching probes to Mars, Venus, Mercury and Jupiter. In 1987, General Dynamics (now Lockheed Martin) funded 18 new commercial Atlas 1 vehicles, which are also known as the Atlas Centaur because of the newly developed second stage, which is also associated with the Titan programme. The first of these launchers was launched in July 1990 and by the end of 1997 ten had been used.

Atlas 1 is a two-stage liquid propellant launcher with typical performance figures of 5,900 kg payloads into LEO and 2,400 kg into GTO. The launcher is 42 m long with a medium payload fairing, and 43.9 m with a large fairing. It has a body diameter of 3.0 m and at launch weighs either 163,900 or 164,290 kg depending on payload fairing used. Stage 1 incorporates two booster engines within a flared skirt and are fired in parallel with the central sustainer motor until the base is jettisoned. During initial flight, the skirt helps to provide some additional stability. Stage 1 is 22.0 m long, has a body diameter of 3.0 m and contains 137,500 kg of liquid propellant. The propulsion system is a Rocketdyne MA-5 with two boosters, one sustainer and two verniers. The boosters have a burn time of 156 seconds and the sustainer 266 seconds. They are gimballed to provide three axis control during stage 1 burn. There is a 3 m long, 447 kg Inter-Stage Adaptor (ISA) to support the Centaur stage 2, which is 9.15 m long, has a body diameter of 3.0 m and at launch contains 13,790 kg of liquid propellant. The propulsion unit is a pair of Pratt & Whitney RL10A-3-3A cryogenic multiple start engines that have a burn time of 408 seconds, and are gimballed for three axis control. Two payload fairings are available 10.36 × 3.3 m or 12.22 × 4.2 m.

Atlas 2

Atlas 2 is a stretched version of Atlas 1 Centaur, and was selected in May 1988 by the USAF as their Medium Launch



A USA Atlas 3 SLV at launch (Lockheed Martin) *2002*/0126681

Vehicle-2 to launch 10 DSCS-3 satellites into GTO. The first Atlas 2 was launched in December 1991 and by the end of 1997 there had been nine successful launches. Typical performance figures are 6,780 kg payloads into LEO, and 2,950 kg into GTO. The overall length of Atlas 2 is 46.8 m with a medium payload fairing, and 47.4 m with a large fairing. It has a body diameter of 3.0 m and at launch weighs either 187,000 or 187,600 kg depending on fairing. Stage 1 is 25.0 m long, has a body diameter of 3.0 m and contains 156,260 kg of liquid propellant. The propulsion system has been improved over the Atlas 1 unit in that, although the sustainer remains the same, the twin booster portion now uses Delta RS-27 engines and the side-mounted verniers have been removed. The boosters have a burn time of 169 seconds and the sustainer 277 seconds. They are gimballed to provide three axis control during stage 1 burn. The ISA is similar to that on Atlas 1 but two hydrazine thruster modules have been added for roll control. The stretched Centaur stage 2 is 10.1 m long, has a body diameter of 3.0 m and at launch contains 16,780 kg of liquid propellant. The propulsion unit is the same as Atlas 1, but the oxidiser/fuel ratio is increased. Burn time is the same as Atlas 1, as are the payload fairings.

Atlas 2A/2AS

Atlas 2A is an enhanced version of the Atlas 2, which became available for commercial use from 1992. The major improvements are the incorporation of Pratt & Whitney RL 10A-4 engines, a deployable extension skirt on the Centaur upper stage, and an improvement in the avionics. Typical performance figures are 6,200 kg to LEO and 3,000 kg to GTO. Atlas 2A was first launched in June 1992 and there had been 12 successful launches by the end of 1997. The Atlas 2A/2AS SLV are now part of the International Launch Services (ILS) capabilities, and are marketed together with the SL-12 Proton, Angara and Atlas 3/5 vehicles.

Atlas 2AS is an uprated version of the Atlas 2A with the inclusion of four solid propellant jettisonable Thiokol Castor 4A boosters. It was first made available in 1993 and flew for the first time in December of that year, and there had been 11 successful launches by the end of 1997. Typical performance figures are 7,300 kg to LEO and 3,700 kg to GTO.

The Castor 4A boosters are 11.3 m long, have a body diameter of 1.0 m, contain 10,200 kg of HTPB propellant and weigh 11,600 kg at launch. Two are ignited on the pad and jettisoned at 88 seconds; the second pair ignites at 57.5 seconds for jettison at 114 seconds. All four have a burn time of 54 seconds and an average thrust of 434 kN at sea level.

Atlas 3A/3B

Lockheed Martin is offering the Atlas 3, renamed from the Atlas 2AR version, which is essentially an Atlas 2AS vehicle with an NPO Energomash RD-180 engine in the first stage. The launches will be marketed by International Launch Services, a joint Lockheed Martin and Energomash company. Two versions of

A Delta 2 satellite launch vehicle launched from Cape Canaveral in March 1989 (USAF)

Atlas 3 are available: Atlas 3A with the capability of putting 4,000 kg into GTO and Atlas 3B capable of putting 4,500 kg into GTO. Atlas 3A is 52.8 m long, has a diameter of 3.05 m and weighs 220,672 kg at launch. Atlas 3B is 53.1 m long, has a diameter of 3.05 m and weighs 225,392 kg at launch. Both versions use the same first stage, which is 29.0 m long, and is powered by the RD-180 engine, which is the first Russian engine in a US SLV and the first variable thrust first-stage engine. The single engine has two nozzles and two combustion chambers, and burns liquid oxygen and kerosene. The Centaur upper stage used on the Atlas 3A is 10.0 m long and is powered by a Pratt and Whitney RL10A-4-1 re-startable motor producing 99.2 kN of thrust. The Centaur upper stage of Atlas 3B is longer at 1.68 m, but uses the same motor. In 2001 it was planned to phase out the Atlas 3A/3B SLVs by 2005, and to use Atlas 5.

Atlas 5

Planned to replace the Atlas 3A/3B SLVs by 2005, Atlas 5 uses some three-quarters of the components of the Atlas 3 including the RD-180 first-stage engine. Atlas 5 was designed to meet a USAF requirement for an Evolved Expendable Launch Vehicle (EELV) following the award of a contract in 1998. Civil launches will be managed by ILS, but military launches will be separately operated by the USAF. Russian-built engines will be used for commercial flights, but Pratt and Whitney-built RD-180 engines will be used for USAF flights. The two-stage medium-lift Atlas 5 has been allocated seven planned launches for the USAF between 2003 and 2006. Atlas 5-400 will have a length of 58.3 m, a body diameter of 3.8 m, and a launch weight of 333,000 kg. Atlas 5-500 will have a length of 66.2 m, a body diameter of 3.8 m, and a launch weight of 540,000 kg. There will be between one and five solid strap-on boosters, depending on the mission requirements. Each booster will be 19.5 m long, 1.57 m diameter, and will weigh 46,300 kg. The HTPB propellant will burn for 90 seconds. The common core first stage has a length of 32.5 m, uses a single RD-180 engine, and carries 285,000 kg of liquid oxygen and kerosene. The RD-180 engine will be throttled back at launch to prevent damage to the launch pad and later to maintain a constant 5.5 *g* acceleration. The Centaur second stage will have a length of 11.68 m, with a RL-104-4-2 cryogenic and re-startable engine. The first launch is planned for 2002, from Cape Canaveral.

Delta 2

In 1959, NASA's Goddard Space Flight Centre contracted Douglas Aircraft Company (now Boeing) to develop an interim space launcher from the company's Thor IRBM and USN's Vanguard upper stages. The programme grew into the Delta 2 family of SLVs, the first being launched in May 1960. By the end of 1997,265 had flown with a success rate of 94 per cent.

The current Delta 2, 7925/7920 series, was first launched in November 1990 and, until the end of 1997, had flown 56 times. There are bookings for a further 85 launches of Delta 2. The 7925 is a three-stage launcher (lower two liquid, upper solid), plus nine solid propellant strap-ons, with typical performance figures of 1,870 kg to GTO, 2,000 kg GPS, and 1,200 kg lunar delivery. It has an overall length of 38.40 m, a body diameter of 2.44 m and weighs 232,000 kg at launch. The Delta 7920 is simply a Delta 7925 without the upper solid propellant stage. It has typical performance figures of 5,000 kg to LEO and 3,000 kg to 830 km sun-synchronous orbits. The Alliant Techsystems GEM strap-on boosters are 13.0 m long, have a body diameter of 1.0 m, contain 11,700 kg of propellant and weigh 13,000 kg at launch. Six are ignited on the pad and jettisoned at 66 seconds (two pairs of three) after their 63 second burn; the other three ignite at 65 seconds for jettison at 132 seconds. The Delta 7920/7925 stage 1 is 26.0 m long, has a body diameter of 2.44 m, weighs 102,000 kg at launch and contains 96,000 kg of usable liquid propellant. The propulsion system is a Rocketdyne RS-27 single start bipropellant engine gimballed for pitch and yaw control, with two Rocketdyne verniers for roll control. The motor has a burn time of 260 seconds. There is a 4.7 m long isogrid interstage extending from stage 1 to stage 2's miniskirt.

The Delta 7920/7925 stage 2 is 6.0 m long, and has a body diameter of 1.7 m with 2.4 m diameter cover and support truss. It weighs 6,900 kg at launch and contains 6,000 kg of usable liquid

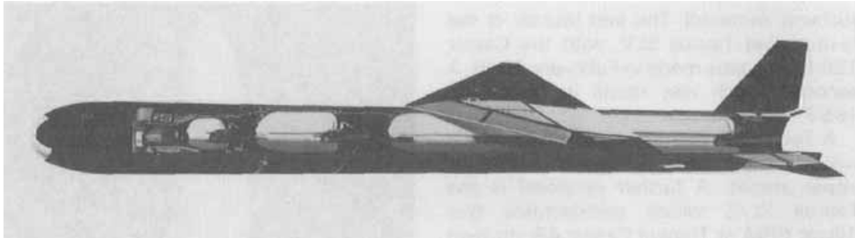
propellant. The engine is a pressure-fed, restartable Aerojet AJ10-118K that has a total burn time of 432 seconds. Attitude control is by the nitrogen cold jet gas Redundant Attitude Control System (RACS) which provides three axis control during coast periods and roll control during powered flight. The Delta 7925 solid propellant stage 3, designated PAM-D, is 2.0 m long, and has a body diameter 1.24 m within the payload fairing. It weighs 2,140 kg at launch and contains 1,725 or 2,025 kg of solid propellant depending on mission. The engine is a Thiokol Star 48B with a burn time of 87 seconds.

Delta 3

In May 1995, MDA (now Boeing) announced that development of a Delta 3 would begin to compete with Ariane and Atlas launchers. Delta 3 is an improved Delta 2 with the ability to deliver payloads of 3,800 kg to GTO and 8,350 kg into LEO. The SLV has a length of 41.1 m. Delta 3 uses nine Alliant Techsystems solid propellant GEM-40 strap-on boosters with TVC on three, and just two liquid propellant stages. The SRBs are 14.22 m long, have a diameter of 1.15 m and a weight of 17,000 kg. The SRBs have a burn time of 83 seconds. The first stage uses the Rocketdyne RS-27A engine and two vernier motors from Delta 2, and the second stage a cryogenic RL-10B2 engine developed by Pratt & Whitney. The payload fairing has been extended to a length of 8.9 m and a diameter of 3.99 m. Delta 3 uses the AlliedSignal avionics and flight control system from the Delta 2. There were 18 commercial launches for Delta 3 booked. The first launch was made in August 1998, but the SLV was destroyed after 55 seconds of flight. The second flight in May 1999 also failed, but the third flight in August 2000 was successful. It is expected that Delta 3 will be phased-out by 2005, in favour of the medium-lift Delta 4.

Delta 4

Boeing's Delta 4 family of SLVs participating in the USAF's Evolved Expendable Launch Vehicle (EELV) programme consists of two classes of launch vehicles, Medium and Heavy. Three variants of the Medium vehicle, known as Medium-plus, have also been introduced to meet the needs of the commercial market. The basic SLV is a two-stage vehicle, with a length varying from 61.0 to 71.6 m. All Delta 4 variants will use the Boeing-built RS-68, liquid hydrogen and liquid oxygen, 2,900 kN (650,000 lb) thrust Common Booster Core (CBC) engine, which has a burn time of 330 seconds. The Delta 4 Medium, which can lift 4,200 kg to GTO or from 8,100 to 11,500 kg to LEO, adds the cryogenic second-stage engine of the Delta 3, and the Delta 3 composite 4.0 m fairing for payload protection. The Delta 4 Heavy, designed to lift 13,200 kg to GTO or 23,000 kg to LEO, links three of the new CBCs together for lift-off and adds a modified and enlarged Delta 3 upper stage engine with larger tanks for increased propellant. Delta 4 Heavy also uses the 5 m metallic fairing that Boeing already manufactures for the Titan 4 launch vehicle.



***A** cutaway diagram of the Pegasus air-launched SLV* (US DoD)

The three commercial derivatives of the medium class launch vehicle are known collectively as the Delta 4 Medium-plus. The three vehicles retain the Delta 4 CBC and are distinguished by the number of Alliant Techsystems built Solid Rocket Booster (SRB) motors attached to the booster core, along with the size of the upper stages and payload fairing. Delta 4 Medium-plus (4.2) is fitted with two SRBs and a 4.0 m diameter fairing for a GTO payload of 5,800 kg. Delta 4 Medium-plus (5.2) has two SRBs and a 5.0 m diameter fairing for a GTO payload of 4,800 kg. Delta Medium-plus (5.4) has four SRBs and a 5.0 m diameter fairing for a GTO payload of 6,700 kg.

In October 1998 the USAF announced the procurement of nineteen Delta 4 launches for the EELV programme, and in 2001 this provisional figure was increased to 21, to be launched between 2003 and 2006. This initial contract covers light, medium and heavy payload-class launches from 2002 to 2006. Launch preparation and testing will take place at Cape Canaveral, Florida, and at Vandenberg Air Force Base, California. Only military payloads will be launched from Vandenberg. Boeing is building a new launch pad, mobile service tower and horizontal integration facility at Space Launch Complex 37 at Cape Canaveral and will modify Space Launch Complex 6 at Vandenberg to handle future launches. Both sites will process rockets horizontally, away from the launch pad to reduce pre-launch on-pad time from 24 days to only six to eight days. The first Delta 4 launch is planned for 2002.

Pegasus

Pegasus is the first satellite launch vehicle designed for aircraft deployment since the early 1960s. Development work on the Pegasus small space launch system was begun by the Orbital Sciences Corporation and Hercules Aerospace partnership in 1987. The basic design is similar to that of a large air-to-surface missile with delta-shaped wings and aircraft-type tail surfaces, capable of carrying 250 kg payloads into 460 km orbit. The first launch took place in April 1990. A converted Lockheed Martin Tristar aircraft is used for the launch. In 1994, a stretched SLV version, Pegasus XL was introduced and to the end of 2000 there had been six standard and ten XL launches. Both versions are air launched at an altitude of 11,500 m (38,000 ft) at around M0.8, with ignition of stage 1 taking place 5 seconds after launch.

The standard Pegasus is a three-stage solid propellant SLV that is 15.5 m long, has a body diameter of 1.27 m and weighs 18,500 kg at launch. Stage 1 is 8.39 m long, has a body diameter of 1.27 m, a wing span of 6.7 m and conventional aircraft-type tail surfaces around a fixed exhaust. At launch it weighs 14,000 kg of which 12.152 kg is HTPB solid propellant. The motor is an Alliant Techsystems Orion 505 that has a burn time of 72 seconds. Attitude control is by the three tail surfaces, and separation is carried out by two linear shaped charges situated in the forward skirt. Stage 2 is 3.83 m long, has a body diameter of 1.27 m and at launch weighs 3,400 kg of which 3,025 is HTPB solid propellant. The motor is an Orion 50, similar to the stage 1 motor but with a burn time of 71 seconds. Attitude control is by nozzle flexing in pitch and yaw. Stage 3 is 2 m long, has a body diameter of 1.0 m and at launch weighs 985 kg of which 782 kg is HTPB solid propellant. The motor is an Alliant Techsystems Orion 38 with a burn time of 64 seconds. Attitude control is the same as stage 2 with coasting roll control provided by six cold gas thrusters. The two piece composite, rounded nose fairing also covers stage 3, and provides a payload envelope of 2.1 × 1.17 m.

The stretched XL version is 16.8 m long, has the same body diameter and weighs 22,500 kg at launch. Stages 1 and 2 are stretched to 10.76 and 4.28 m respectively and weigh accordingly. Stage 3 and fairing stay the same.

Taurus

The Taurus is basically a Pegasus vehicle with an additional first stage solid propellant motor replacing the carrier aircraft. It was developed by Orbital Sciences Corporation to meet the Standard Small Launch Vehicle (SSLV) contract requirement of a self-contained road transportable system, capable of rapid response from austere sites. The original SSLV requirement was for a 450 kg payload into a 740 km polar orbit. This was increased to 815 kg in 1991. The first Taurus launched in March 1994 used the standard Pegasus with wings and tail surfaces removed and a Thiokol LGM-118 Peacekeeper stage 1 as a lower stage. Subsequent launches have used a Thiokol Castor 120 motor, which was based on Peacekeeper stage 1 technology. Taurus is a four-stage solid propellant launcher designed to carry typical payloads of 800 kg to 700 km and 1,300 kg to 400 km. It has an overall length of 27.7 m, a body diameter of 2.34 m (first stage), 1.27 m (upper stages), and a launch weight of 72,576 kg. Stage 1 is 7.72 m long and, with 49,000 kg of HTPB propellant, weighs 53,000 kg at launch. The motor is a Thiokol Castor 120 with a burn time of 83 seconds. Stages 2, 3, 4, and payload fairing are the same as the standard Pegasus with wing and tail

surfaces removed. The first launch of the re-modelled Taurus SLV, with the Castor 120 motor, was made in February 1998. A second launch was made in December 1999.

A Taurus XL has been proposed which will use the stretched Pegasus XL for its upper stages. A further proposal is the Taurus XL/S which incorporates two Alliant GEM or Thiokol Castor 4B strap-on motors. This vehicle would have a capability of carrying 1,750 kg to LEO or 670 kg to GTO.

Titan 2

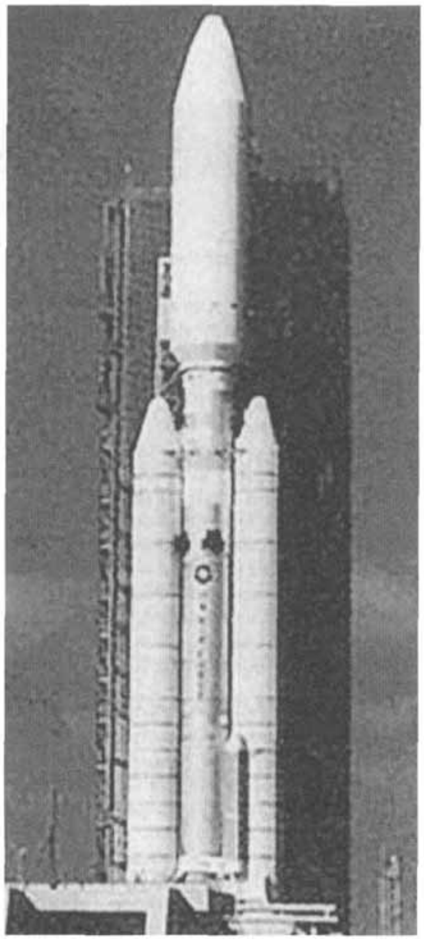
The Lockheed Martin Titan 2 SLV was derived from the LGM-25C Titan 2 ICBM, which was first launched in 1962 (for further details of LGM-25C see separate entry in Obsolete Offensive Weapons). The first launch of a Titan 2 SLV was in April 1964 (Gemini 1), and to the end of 1999 around 20 successful launches had been carried out.

Titan 2G is the baseline vehicle of the space launcher range. It is a two-stage liquid propellant launcher that was designed to carry 1,500 kg plus into GTO and to place 3,000 kg in sun-synchronous polar orbits at 560 km. The 2G is 33.6 m long plus payload, has a body diameter of 3.0 m and weighs 154,000 kg at launch. Stage 1 is 21.4 m long, has a body diameter of 3.0 m, a dry weight of 4,220 kg, and contains 118,300 kg of liquid propellant. The motor is a gimballed paired Aerojet LR87-AJ-5 single start hypergolic that has a burn time of 158 seconds. Stage 2 is 12.2 m long, has a body diameter of 3.0 m and a dry weight of 2,860 kg. At launch it contains 28,440 kg of liquid oxygen and kerosene. The motor is an Aerojet LR91-AJ-5 single start hypergolic single chamber that has a burn time of 440 seconds. The standard payload fairing is 9.2 m long, has a body diameter of 3.0 m, and provides a payload envelope of 9.0 × 2.8 m. The Titan 2S (Solid Thrust Augmented) variant is formed by adding two to eight Thiokol Castor 4A solid propellant strap-on boosters to the Titan 2G. These boosters are 11.0 m long, have a body diameter of 1.0 m and weigh 11,600 kg when filled with 10,000 kg of solid propellant. The burn time of the strap-on boosters is 53 seconds.

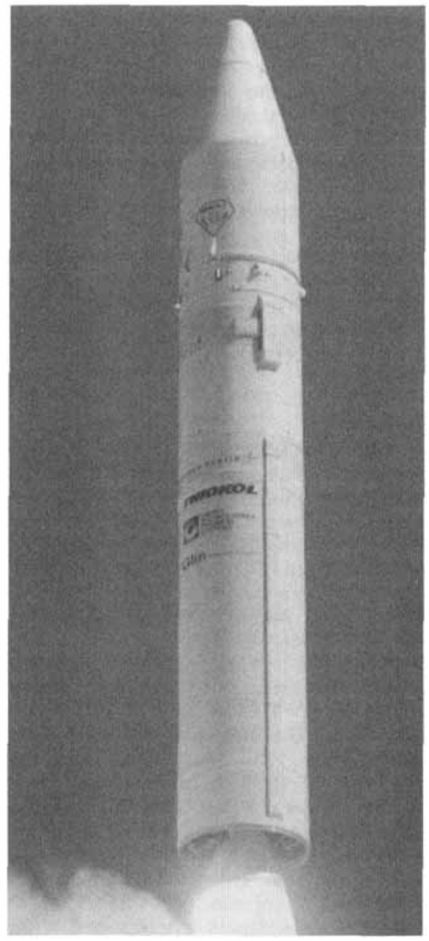
Titan 3

The first Titan 3 was launched in September 1964 and, by the end of 1997, the number launched was 156 with a reported success rate of 91 per cent. Titan 3 is a two-stage liquid propellant, boost assisted launcher that was designed to carry single or dual 14,000 kg plus payloads into LEO.

Titan 3 is 44.0 m long (single payload), 47.0 m (dual payload), has a body diameter of 3.0 m and weighs 680,000 kg at launch. The two United Technologies' strap-on Solid Rocket Booster (SRB) motors are attached to either side of the first stage. These are 27.57 m long, have a body diameter of 3.0 m and weigh 250,000 kg at launch of which 210,000 kg is UTP-30001B propellant. They have a burn time of 113 seconds and are jettisoned after burnout. Stage 1 is 24.0 m long, has a body diameter of 3.0 m, and contains 71,700 kg of nitrogen tetroxide oxidiser in a forward tank and 38,000 kg of Aerozine-50 fuel in the aft tank. The engine is a paired gimballed Aerojet LR87-AJ-11, ignited at 116 seconds and burns for about 160 seconds. Stage 2 is 9.85 m long, has a body diameter of 3.0 m, and contains 18,300 kg of nitrogen tetroxide oxidiser in a forward tank and 10,300 kg of Aerozine-50 fuel in the aft tank. The engine is a single gimballed LR91-AJ-11 that has a burn time of 225 seconds. The payload fairing is 10.4 m long and has an internal diameter of 3.95 m.



A Titan 4 Centaur being prepared for launch (Lockheed Martin) 2000/0062803



The first Athena 1 SLV at launch (Lockheed Martin) 0022183

Titan 4

Titan 4 was first launched in June 1989 and the latest most powerful version, the Titan 4B, was first launched in 1997. By the end of 2001, the number of Lockheed Martin Titan 4 variants launched was 26, with five failures. It is a three-stage liquid propellant, boost-assisted launcher that was primarily designed to carry large military payloads of up to 5,000 kg into GTO. Titan 4 is 54.0 m long (IUS stage 3). 63.1 m (Centaur stage 3). has a body diameter of 3.0 m and weighs 924,000 kg (IUS) or 940,000 kg (Centaur) at launch. The two Alliant Techsystems strap-on Solid Rocket Booster (SRB) motors are attached to either side of the first stage. These are 34.0 m long, have a body diameter of 3.2 m and weigh 350,000 kg at launch of which 344,000 kg is HPTB propellant. They have a burn time of 145 seconds.

Stage 1 is 26.4 m long, and has a body diameter of 3.0 m. It contains 111,000 kg of nitrogen tetroxide oxidiser and 59,000 kg of Aerozine-50 fuel. The engine is a paired gimballed Aerojet LR87-AJ-11; it is ignited at 116 seconds and burns for about 186 seconds. Stage 2 is 9.94 m long and has a body diameter of 3.0 m. It contains 24,500 kg of nitrogen tetroxide oxidiser and 13,900 kg of Aerozine-50. The engine is an Aerojet single gimballed LR91-AJ-11A that has a burn time of 240 seconds. The IUS and Centaur are the principal upper stages for Titan 4, but others are available. The IUS stage 4 *is* 5.0 m long, has a body diameter of 2.9 m and weighs 16,200 kg at launch. It is powered by a CSD Orbus solid propellant engine that has a burn time of 152 or 289 seconds depending on mission. The Centaur stage 4 is 8.9 m long, has a body diameter of 4.5 m and weighs 26,000 kg at launch. It is powered by a Pratt & Whitney RL10-3-3A liquid propellant engine that has a total burn time of 617 seconds. The payload fairing for the IUS version of Titan 4 is 17.06 m long and the Centaur version is 26.0 m long. Both have a body diameter of 5.0 m.

The Titan 4B version, first launched in February 1997, has been designed to put loads of up to 22,500 kg into LEO or 5,700 kg into GTO. The launcher has a total length of 62.15 m and a lift-off weight of 1,318,000 kg. The Titan 4B uses two newly developed Alliant Techsystems solid propellant strap-on boosters, each with a

diameter of 3.2 m, a weight of 350,000 kg and with new hydraulic steered nozzles. These boosters use HTPB propellant and burn for 138 seconds, with the main first stage Aerojet LR-87 motor not being ignited until these boosters have completed their burn.

Athena 1/2/3

Lockheed Martin has developed the Athena family of SLVs, originally called the Lockheed Martin Launch Vehicles (LMLV), from 1992. Athena 1 was first launched in 1995, but that launch was unsuccessful, and there have now been three more launches, in August 1997, January 1999 and October 2001. The fourth launch was made from the Kodiak Island launch facility in Alaska, USA. Athena 1 is a two-stage solid propellant SLV, designed to put up to 800 kg in LEO. It has a length of 20.0 m, and a launch weight of 66,000 kg. The first stage is a Thiokol Castor 120 motor, and the second stage a United Technologies Orbus 2 1D motor.

The Athena 2 SLV has three stages, all solids, using two Castor 120 motors as the first and second stages, with a third stage Orbus 21D. This version has a length of 21.3 m, and a launch weight of 120,000 kg. There are two options for payload fairings: one has a length of 7.42 m and a diameter of 2.74 m; and the second has a length of 9.07 m and a diameter of 3.23 m. Athena 2 has the capability to put up to 2,000 kg into LEO. The first launch was made in 1998 and there have been two more launches.

Athena 3 is a proposal for a greater lift capability using the Athena 2 configuration but with 2, 4 or 6 solid propellant strap-on boosters, giving a maximum capability of putting 3,600 kg into LEO. The length will be 33.0 m, and the launch weight up to 193,000 kg. Athena 3 has not flown yet.

Minotaur

This is a joint USAF and Orbital Sciences Corporation development, for small US government payloads only, using obsolete Minuteman II first- and second-stage motors with the third and fourth stages from the Taurus SLV. The first stage uses the M55A1 motor from Minuteman II, and this stage has a length of 7.3 m. The second stage uses the SR-19 motor, and this stage has a length of 4.0 m. The third stage uses the Orion 50 XL motor, and has a length of 3.63 m. The fourth stage uses the Orion 38 motor, and this stage has a length of 1.32 m. The Minotaur SLV has a length of 19.18 m, a body diameter of 1.66 m, and can place up to 350 kg in LEO. The first launch was made in January 2000, and the second in July 2000.

Alacran

Type
Short-range, ground-launched, solid-propellant, single warhead ballistic missile.

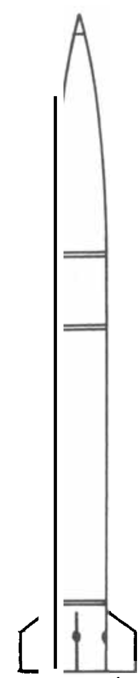
Development
It is believed that the Alacran missile was designed and developed in the 1980s alongside the Condor 1 (C1-A3) space launch vehicle. Condor 1 was displayed at the Paris Air Show in 1985, and it is believed that Alacran was a specific short-range ballistic missile project using the technologies proven by the Condor 1 programme. It is not known if there was any commonality between Alacran and the later international Condor 2 collaborative programme between Argentina, Egypt and Iraq (see separate entry).

Description
The Alacran missile is believed to be about 6.2 m long with a body diameter of 0.56 m. The missile has four clipped-tip, moving delta control fins at the base, for aerodynamic control within the atmosphere. It is estimated that the missile has a launch weight of 1,620 kg and a single conventional HE warhead of 400 kg. The missile has inertial guidance. A report indicates that two alternative submunition payloads have been developed for Alacran: either 1,020 CAM-I submunitions; or 176 MOR-1 anti-tank and anti-personnel grenades. Alacran has a single-stage solid-propellant motor and a range of about 150 km.

Operational status
A first launch of the Condor 1 space launch vehicle was reported in 1986 and the first launch of the Alacran missile was reported early in 1989, from the El Chamical test facility in La Rioja. It is assumed that the lengthy development programme was due to budget restraints. An unconfirmed report from Argentina states that Alacran entered service in 1990 and that Iran might have bought some missiles; however, it may have been that Iran purchased some technologies from the programme. There is no confirmation that these missiles are still in service, but it is possible that they have been retained in storage.

Specifications
Length: 6.2 m
Body diameter: 0.56 m
Launch weight: 1,620 kg
Payload: Single warhead; 400 kg
Warhead: HE, chemical or submunitions
Guidance: Inertial
Propulsion: Single-stage solid
Range: 150 km
Accuracy: n/k

Contractor
The initial design was most probably completed by the Instituto de Investigaciones Aeronauticas y Espaciales (IIAE), with development by Fabrica Argentina de Material Aeroespatiale (FMA), Cordoba.



The Alacran short-range ballistic missile

CF-2000

Type
Short-range, ground-launched, solid propellant, single-warhead, surface-to-surface missile.

Development
A new missile was reported in 1999, with the Chinese designator Chang-Feng-2000 (CF-2000) which is translated as Long Wind-2000. This missile appears to be similar to that displayed in 1998, with the Chinese FT-2000 anti-radar surface-to-air missile system. The FT-2000 was offered for export by CPMIEC, and is believed to have the Chinese designator HQ-15. The CF-2000 missile is similar to the Russian SA-11 'Gadfly' in shape, but is believed to be based on the earlier SA-10A/B/C 'Grumble' missile design, but with four wings and two solid propellant boost motors added for additional range. China has built SA-10C missiles under licence, with the designator HQ-10, and has also built an improved version designated HQ-9. HQ-16 is a joint Chinese-Russian development programme to improve on Russian SA-11 and SA-17 'Grizzly' missile systems. The first flight test for CF-2000 was probably made in 1998.


A CF-2000 missile *at* launch 0099497

Description
There have been few details released about the CF-2000 missile system. It is believed to be similar to the FT-2000 surface-to-air system, but with a modified missile. The CF-2000 missile is probably based upon the Russian SA-10A/B/C (5V55) series missiles, with long chord wings similar to the SA-11 missile for additional range. The missile is believed to be 6.8 m long, to have a body diameter of 0.47 m, and a launch weight of 1,600 kg. The launch weight includes two 150 kg strap-on boost motors, with the missile weighing 1,300 kg. The missile has a rounded radome at the nose, probably with a millimetric wave active radar seeker. There are four long chord wings at the rear of the missile with a span of 1.1 m, and these wings have a rounded leading edge. Two solid propellant boost motors are strapped to the missile body between the wings and fins. At the rear of the missile there are four moving clipped-tip delta control fins. The warhead weight is believed to be 130 kg, and to be a HE blast/fragmentation type. Guidance in mid-course is probably inertial with GPS/Glonass updates. With a millimetric wave active radar seeker for the terminal phase, probably using radar correlation for aim point determination, an accuracy of 20 to 50 m CEP would be expected. The missile has a solid propellant sustainer motor, and it is expected that either high altitude (over 10 km) or low level cruise trajectories can be flown. At high altitude the maximum cruise speed would probably be around M 3.0, with M 2.0 at low level. The minimum range is believed to be 20 km, and the maximum range (only with a high-level cruise trajectory) 150 km. It is believed that the CF-2000 missile system uses the same transporter-erector-launcher vehicle as the FT-2000 SAM system, which is a modified version of the Russian SA-10 'Grumble' eight wheeled vehicle with the Russian designator 5P85S. This vehicle carries four missiles in their distinctive round ribbed canisters, and was also used by the earlier Russian ground-launched cruise missile, the SSC-X-4 'Slingshot'.


A Chinese *TEL* vehicle. used with the *FT-2000 SAM* system, *but* believed *to* be used with *CF-2000 as well* (CPMIEC) 0044948

Operational status
The CF-2000 missile system was first reported in 1999, and it is not known if this missile is still in development or has entered operational service in China. There are no reported export orders.

Specifications
Length: 6.8 m
Body diameter: 0.47 m
Launch weight: 1,600 kg (with two boost motors)
Payload: Single warhead
Warhead: 130 kg HE
Guidance: Inertial with GPS, and active radar
Propulsion: Solid propellant
Range: 150 km
Accuracy: n/k

Contractor
CPMIEC, Beijing

CSS-2 (DF-3)

Type

Intermediate-range, surface-based, liquid-propellant, single warhead ballistic missile.

Development

In the mid-l950s the former Soviet Union supplied China with a number of SS-2 'Sibling' missiles, which were an adaptation of the German Second World War style V-2 short-range ballistic missile. Later, some SS-2 missiles were produced locally under licence and designated DF-1 *(Dong Feng* = East Wind) by the Chinese. The first Chinese ballistic missile launch took place in November 1960 using a DF-1 fitted with a dummy payload. It now seems certain that the Chinese also had limited access to the somewhat larger SS-3 'Shyster' missile, a Russian development of the SS-2. Following the break with Moscow in the early 1960s. China used its existing production base to build its first indigenous missile, known in the West as the CSS-1 (Chinese Surface-to-Surface Missile-l) and in China as Dong Feng-2. Some sources suggest that the CSS-1 was derived from the SS-3 'Shyster' airframe but used an upgraded SS-2 'Sibling' propulsion system (liquid oxygen and alcohol) known to have been manufactured in China. The date of the first CSS-1 launch is uncertain, but is generally thought to have taken place in June 1964. What is known is that a CSS-1 was used to launch a nuclear warhead into the Lop Nor atomic test area in October 1966. Production is believed to have ended in 1969 after 100 missiles were built, of which about 90 were deployed through the 1970s. One of the main shortcomings of the CSS-1 as a weapon was the use of liquid oxygen as fuel, the missile could not be stored fully fuelled for long periods or launched at short notice. Recognising this, in the early 1960s. the Chinese started the development of a series of missiles using only storable propellants. The first of these was the CSS-2, which had the Chinese designation DF-3, with a range requirement of 2,500 km sufficient to attack US bases in the Philippine Islands. CSS-2 has a payload of 2,000 kg, as this was the expected weight of the original hydrogen bomb under development in China at that time. Test flights were reported from 1966 to 1968 and the missile is believed to have entered service in 1970. An improved version, the DF-SA, was developed in the early 1980s, with flight tests starting in 1986. The DF-3A has an increased range and improved accuracy, and a conventional high-explosive warhead was developed for an export order to Saudi Arabia. In 1985, flight tests began of a modernised CSS-2 missile with a new delivery system. probably a Multiple Re-entry Vehicle (MRV) type which, according to Chinese sources, would have the ability to place re-entry vehicles on dispersed targets. However, it is believed that the tests were unsuccessful and the missile remains with a single warhead. While the CSS-2 served well as an Intermediate-Range Ballistic Missile (IRBM), its limited range made it relatively ineffective against key targets. With this in mind, the Chinese developed, essentially in parallel with the CSS-2, the two-stage CSS-3 (designated DF-4). The DF-4 missile went on to form the baseline design for the Chinese Long March satellite launch systems used throughout the 1980s and 1990s.

Description

The CSS-2 (DF-3) is a single-stage, liquid-fuelled ballistic missile, 21.2 m long and 2.25 m in diameter, with four clipped delta fins at the base of the missile. The missile has a launch weight of 64,000 kg and it is thought that, in the early days, it probably used a ground-based radio-command guidance system similar to those employed on some early US missiles. This was changed later for inertial guidance. The CSS-2 uses vanes in the efflux nozzles for control during the boost phase of flight. The motor consists of a cluster of four YF-2 engines which use storable liquids, Unsymmetrical Dimethyl Hydrazine (UDMH) fuel and AK-27 oxidiser (nitric acid with 27 per cent nitrogen tetroxide), and provide a total thrust of 96 tonnes. The motors have a burn time of around 140 seconds. This gives the DF-3 missile a minimum range of 750 km and a maximum range of 2,650 km. At maximum range, the peak velocity of CSS-2 will be 4.7 km/s. DF-3 has a separating warhead assembly, weighing 2,150 kg, and it carries a single nuclear warhead with a yield between 1 and 3 MT. The accuracy is believed to be 2,000 m CEP.

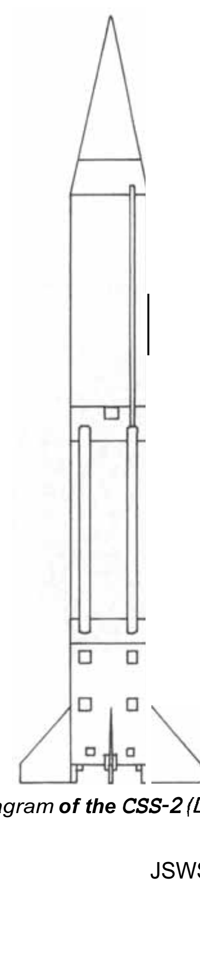
The improved DF-3A version has a range increased to 2,800 km and an accuracy improved to 1,000 m CEP. The pre-launch preparation time is reported to be between 2 and 3 hours. However, if the payload were reduced, then the DF-3A version would have the capability to achieve a range of about 4,000 km.

A conventional high-explosive warhead was developed in China for fitting to the DF-3 (or DF-3A) missiles exported to Saudi Arabia, with a weight of 2,500 kg. These missiles are believed to have a maximum range of 2,400 km.

Operational status

CSS-2 (DF-3) is believed to have entered service in 1970, after a series of flight tests from 1966 to 1968, and about 100 to 150 are reported to have been deployed. The missile is believed to be transportable, with basing at permanent sites from which targets in central and eastern Asia could be reached. Two test firings of the improved DF-3A in 1986 suggest a capability for relocation of launch facilities, without the implication that the missile is truly mobile. The DF-3A is believed to have entered service in China in 1987. A test launch was made in August 2001, from Haiyan. DF-3 and -3A missiles were deployed at Dalong. Datong, Dengshahe, Dienwei, Fungrun,

A CSS-2 ballistic missile at launch (Xinhua News Agency) 0003102



A line diagram of the CSS-2 (DF-3)

The CSS-2 intermediate-range missile 0003101

Jianshui, Kunming, Lianxiwang, Liujikou, Tonghua, Wuwei, Xian and Yidu. The training facilities for DF-3 missiles were at Wuwei, near Shuangta, with training launches made from Wuchai, Haiyan and Shuangchengtzu. The CSS-2 gained considerable attention in 1987, through its introduction to the Middle Eastern theatre, in Saudi Arabia, where it is reported that 50 to 60 conventional warhead missiles have been deployed at two sites with four to six launch pads per site. It is believed that some 10 to 15 transporter vehicles were also supplied to Saudi Arabia. Further unconfirmed reports suggest that chemical warheads have been developed for the CSS-2 missiles in Saudi Arabia. It is not clear if the Chinese exported DF-3 missiles to Saudi Arabia and built more DF-3A to replace them, or if the sale to Saudi Arabia was made from refurbished in-service missiles. There have been no reported flight tests of the CSS-2 missiles from Saudi Arabia. There were believed to be between 60 and 80 missiles deployed in 1990. It is reported that the DF-3A missiles began to be removed from service from 1996 onwards, being replaced by DF-21A solid propellant missiles. A small number, probably around 20, were believed to remain in service at the end of 2001.

Specifications

DF-3
Length: 21.2 m
Body diameter: 2.25 m
Launch weight: 64,000 kg
Payload: Single warhead 2,150 kg
Warhead: Nuclear 1-3 MT
Guidance: Inertial
Propulsion: Single-stage liquid
Range: 2,650 km
Accuracy: 2,000 m CEP

DF-3A
Length: 21.2 m
Body diameter: 2.25 m
Launch weight: 64,000 kg
Payload: Single warhead (2,150 kg or 2,500 kg)
Warhead: Nuclear 1-3 MT or HE
Guidance: Inertial
Propulsion: Single-stage liquid
Range: 2,800 km (or 2,400 km HE)
Accuracy: 1,000 m CEP

Contractor

It is believed that DF-3 was designed by the First Academy of the Ministry of Aerospace Industries, now called the China Aerospace Industry Corporation, Beijing. Final tests are made at the Wanyaun Industry Corporation, Beijing.

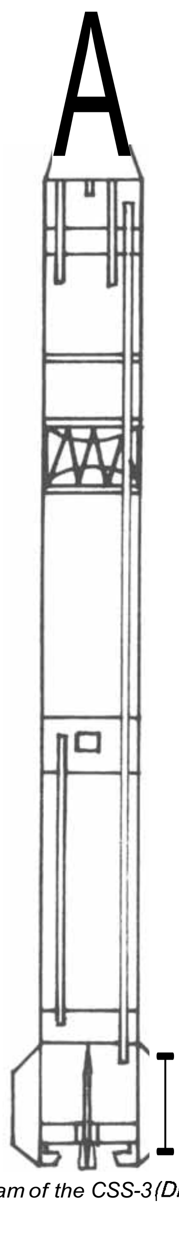
CSS-3 (OF-4)

Type

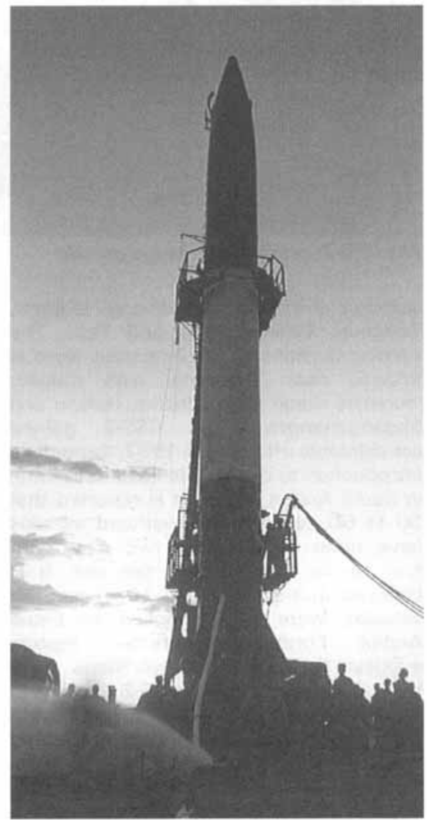
Intermediate-range, surface-based, liquid propellant, single warhead ballistic missile.

Development

In the mid-I 950s the former Soviet Union supplied China with a number of SS-2 'Sibling' missiles which were an adaptation of the German Second World War style V-2 short-range ballistic missile. Later, some SS-2 missiles were produced locally under licence and designated DF-1 *(DongFeng=* East Wind) by the Chinese. The first Chinese ballistic missile launch took place in November 1960, using a DF-1 fitted with a dummy payload. It now seems certain that the Chinese also had limited access to the somewhat larger SS-3 'Shyster' missile, a Russian development of the SS-2. Following the break with Moscow in the early 1960s. China used its existing production base to build its first indigenous missile, known in the West as the CSS-1 (Chinese Surface-to-Surface Missile-I) and in China as Dong Feng-2. Some sources suggest that the CSS-1 was derived from the SS-3 'Shyster' airframe but used an upgraded SS-2 'Sibling' propulsion system (liquid oxygen and alcohol) known to have been manufactured in China. The date of the first CSS-1 launch is uncertain, but is generally thought to have taken place in June 1964. What is known is that a CSS-1 was used to launch a nuclear warhead into the Lop Nor atomic test area in October 1966. Production is believed to have ended in 1969 after 100 missiles, of which about 90 were deployed through the 1970s. In the early 1960s. the Chinese started the development of a series of missiles using only storable propellants and the first of these was the CSS-2, which had the Chinese designation DF-3. Test flights were reported in 1966 and the missile is believed to have entered service in 1970. The Chinese developed, essentially in parallel with the CSS-2, the two-stage CSS-3, designated DF-4, with a range requirement of 4,000 km to attack the US bases on the island of Guam. While a degree of uncertainty surrounds details of the CSS-3, it is known to have led to its three-stage civilian derivative, the Long March-I (LM-1). LM-1 wasthevehicle used for the first successful Chinese satellite launch in 1970. It is believed that CSS-3 development started in 1965, and it was used to develop technologies and equipment essential for the CSS-4 by means of several test flights. One of the key developments is thought to have been the strapdown inertial guidance system used on the LM-1 and, possibly, on the CSS-4. The first test launch of CSS-3 was carried out in 1970, but a redesign followed due to the requirement to increase the range to 4,500 km, so as to be able to attack Moscow and other key former USSR cities. The system finally became operational in 1980. The Chinese carried out six tests of nuclear warheads with yields in the 1 to 3 MT range between 1967 and 1976, and it is believed that this warhead was developed for DF-2, DF-3 and DF-4 missiles. According to official Chinese reports, the 2nd Artillery Corps completed a series of software upgrades for their strategic missiles in 1985, to improve the accuracy and to simplify pre-launch procedures. There were only two successful LM-1 launches made in 1970 and 1971 but, in 1985, the Chinese offered an LM-IC three-stage liquid-propellant satellite launch vehicle for use with a launch weight of 88,000 kg. In 1988 an LM-1D version was offered, with two liquid stages and a solid-propellant third stage, and a launch weight of 81,000 kg. There have been no reported launches of either the LM-IC or LM-1D versions.



A line diagram of the CSS-3 (DF-4)



A CSS-3 ballistic missile being prepared for launch (Military World) 0003104

Description

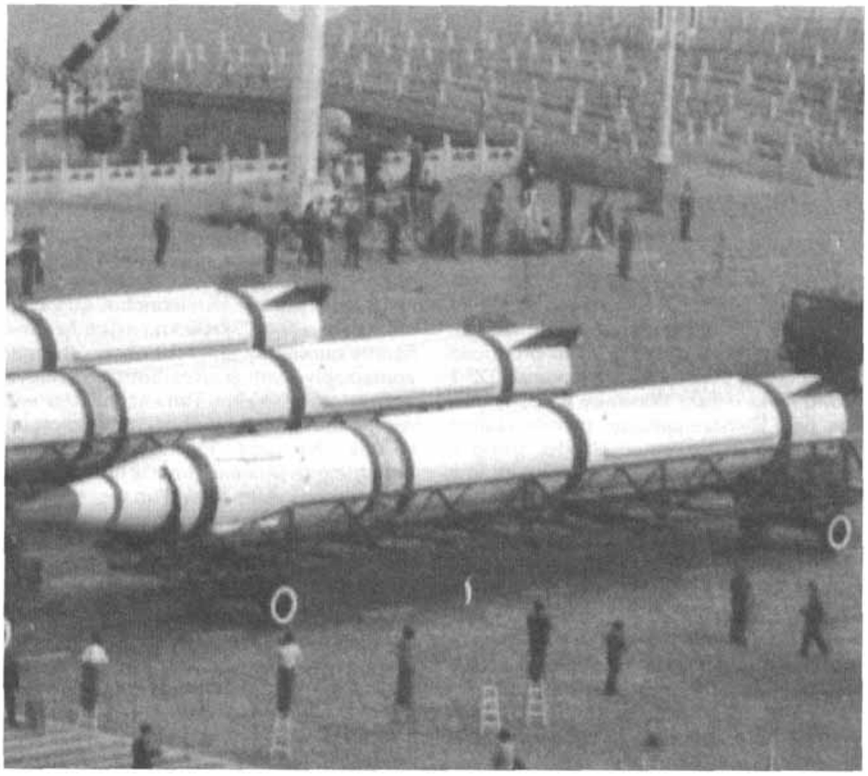
The CSS-3 is a two-stage, liquid-fuelled ballistic missile, 28.0 m long and 2.25 m in diameter, with four clipped delta fins at the base of the first stage. It has a launch weight of 82,000 kg. The first stage has a length of 16.7 m, the second stage 7.0 m, and the warhead assembly a length of 4.3 m. The inertial strapdown guidance system operatesvanes in the efflux nozzles for control during the boost phase. The first stage is an uprated CSS-2 (DF-3) stage with four YF-2A motors giving a total thrust of

The second stage aiid warhead assembly ofa CSS-3 interniediate-range missile

104 tonnes. The second stage has one YF-3 motor giving 32 tonnes thrust. Both stages use the same storable liquid propellants as DF-3, UDMH and AK-27. The payload consists of a single nuclear warhead believed to have a yield of between 1 and 3 MT, with the total payload weight 2,200 kg. The payload assembly separates from the second stage after motor burnout. The CSS-3 minimum range is believed to be 1,200 km, and the maximum range 4,750 km. An accuracy of around 1,500 m CEP has been ascribed to this missile system.

Operational status

The first test launch of CSSS was made in 1970 but, following a re-design in order to increase the range, the missile was re-tested in the late 1970s. Two CSS-3 (DF-4) missiles are reported to have been deployed in 1980, with a maximum of 10 to 25 believed to be operational from 1985 onwards. Deployment is reported to be concentrated in western China at Qaidam, Delingha. Tongdao. Sundian and Xiao Qaidan, where targets in Russia would be accessible. Early trials experimented with silo-based and rail-based launches for CSS-3, but later missiles were stored in caves. The missiles are prepared for launch in the caves and then moved outside immediately before launching. The first launch from a cave area was reported in 1980. It is believed that around 20 to 35 CSS-3s were produced, but there are no known exports. The DF-4 bases were believed to have been upgraded during the Great Wall project from 1985 to 1995. The missiles were expected to be removed from service between 2001 and 2005, and replaced by solid propellant DF-31 missile systems, but there is no confirmation that this has occurred.



CSS-3 ballistic missiles being paraded in Beijing *0003103*

Specifications

Length: 28.0 m
Body diameter: 2.25 m
Launch weight: 82,000 kg
Payload: Single warhead; 2,200 kg
Warhead: 1-3 MT nuclear
Guidance: Inertial
Propulsion: 2-stage liquid
Range: 4,750 km
Accuracy: 1,500 m CEP

Contractor

It is believed that DF-4 was designed by the First Academy of the Ministry of Aerospace Industries, now called the China Aerospace Industry Corporation, Beijing. Final testing was carried out at the Wanyuan Industry Corporation, Beijing.

CSS-4 (OF-5)

Type

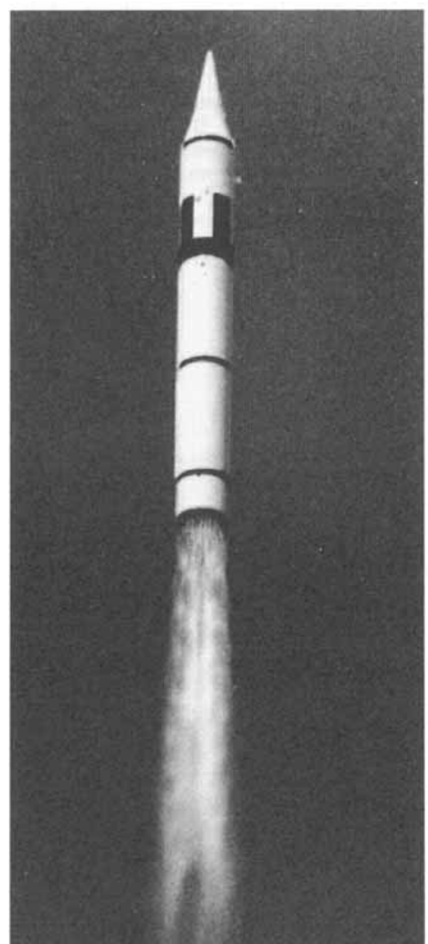
Inter-continental-range, silo-based, liquid propellant, single warhead ballistic missile.

Development

In the mid-1950s the former Soviet Union supplied China with a number of SS-2 'Sibling' missiles, which were an adaptation of the German Second World War style V-2 short-range ballistic missile. Later some SS-2 missiles were produced locally under licence and designated DF-1 ***(Dong Feng** =* East Wind) by the Chinese. The first Chinese ballistic missile launch took place in November 1960, using a DF-1 fitted with a dummy payload. It now seems certain that the Chinese also had limited access to the somewhat larger SS-3 'Shyster' missile, a Russian development of the SS-2. Following the break with Moscow in the early 1960s. China used its existing production base to build its first indigenous missile, known in the West as the CSS-1 (Chinese Surface-to-Surface Missile-1) and in China as Dong Feng-2. Some sources suggest that the CSS-1 was derived from the SS-3 'Shyster' airframe but used an upgraded SS-2 'Sibling' propulsion system (liquid oxygen and alcohol) known to have been manufactured in China. The date of the first CSS-1 launch is uncertain, but is generally thought to have taken place in June 1964. What is known is that a CSS-1 was used to launch a nuclear warhead into the Lop Nor atomic test area in October 1966. In the early 1960s the Chinese started the development of a series of missiles using only storable propellants. The first of these was the CSS-2, which had the Chinese designation DF-3. The Chinese developed, essentially in parallel with the CSS-2, the two-stage CSS-3 designated DF-4. While a degree of uncertainty surrounds details of the CSS-3, it is known to have led to its three-stage civilian derivative, the Long March-I (LM-1). LM-1 was the vehicle used for the first successful Chinese satellite launch in 1970. It is believed the CSS-3 was used to develop technologies and equipment essential for the CSS-4 by means of several test flights. One of the key developments is thought to have been the strapdown inertial guidance system used on the LM-1 and possibly on the CSS-4. The requirement for the CSS-4 (Chinese designator DF-5) was to have a range of 12,000 km to attack a wide variety of US East and West Coast targets. Research started in 1965, but the programme required many new technologies and the first flight test was not made until 1971. There were at least five test firings of the CSS-4 during 1979 and a further *two* in May 1980. The first silo launch was made in 1979. The latter two launches achieved ranges of about 7,000 km, although the figures quoted by different observers vary appreciably, with figures both below this and up to 15,000 km. The impact area was within the area bound by the Solomon Islands, Fiji and the Gilbert Islands. According to Chinese reports of the event, no warheads were carried on these firings. In the late 1960s. two further programmes are believed to have been designed from the DF-5: a DF-6 fractional orbital bombardment system to attack the USA from a south-westerly direction (cancelled in 1973). and a penetration aid programme. The Chinese carried out six tests of nuclear warheads with yields in the 1 to 3 MT range between 1967 and 1976, and it is believed that this warhead was developed for the DF-2, DF-3, DF-4 and DF-5 missiles. The First Academy are reported to have developed chaff and lightweight exoatmospheric decoys for the DF-5 missile, and to have started a multiple independently targeted re-entry vehicle (MIRV) programme in 1970. The MIRV programme was delayed by lack of progress on small nuclear warheads and DF-5 entered service with a single large nuclear warhead in 1981. The MIRV project was restarted in 1983, but flight tests on DF-3 missiles in 1985 were unsuccessful, and it is believed that no MIRV capability exists on DF-5 missiles. An improved version, known as DF-5A. is reported to have been developed and deployed in 1986, having better reliability, improved accuracy and a range increase to 13,000 km. An unconfirmed report from the USA in 1999, suggested that some DF-5A missiles may have been fitted with four or six MIRV warheads from the DF-31/ JL-2 programme, with yields in the 150 to 350 kT range. The Chinese carried out seven tests between 1966 and 1983 with 150 to 350 kT yield nuclear warheads, and these could have been developed small enough to fit the DF-5A payload bay. The civil version of this missile, used for space launch applications, is called the Long March-2C. which has the alternative Chinese designation CZ-2C. (The LM (Long March) designation is often seen as 'CZ' (Chang Zheng)). There have been 13 reported LM-2C launches, the first in November 1975 and the last in 1993, which launched a German experimental package into space. All the LM-2C launches have been made from the Jiuquan launch site. This launcher appears to be the workhorse of the Chinese satellite programme and there have been further development programmes resulting in the LM-2D. LM-2E. LM-3 and LM-4 satellite launch vehicles (for further details see Unclassified Projects section).

Description

The CSS-4 (DF-5) is a two-stage, liquid-fuelled intercontinental ballistic missile, 32.6 m long and 3.35 m in diameter. The first stage length is 20.5 m, the second 7.6 m and the warhead and re-entry section is 4.5 m long. The missile has a launch weight of 183,000 kg. The gyro-stabilised inertial guidance system has an onboard computer and operates gimbaled engines for control. The first stage motor consists of a cluster of four YF-20 engines, which use storable liquids, Unsymmetrical



A CSS-4 (Dong Feng-5) inter-continental ballistic missile at launch
(Xinhua News Agency) 0003126

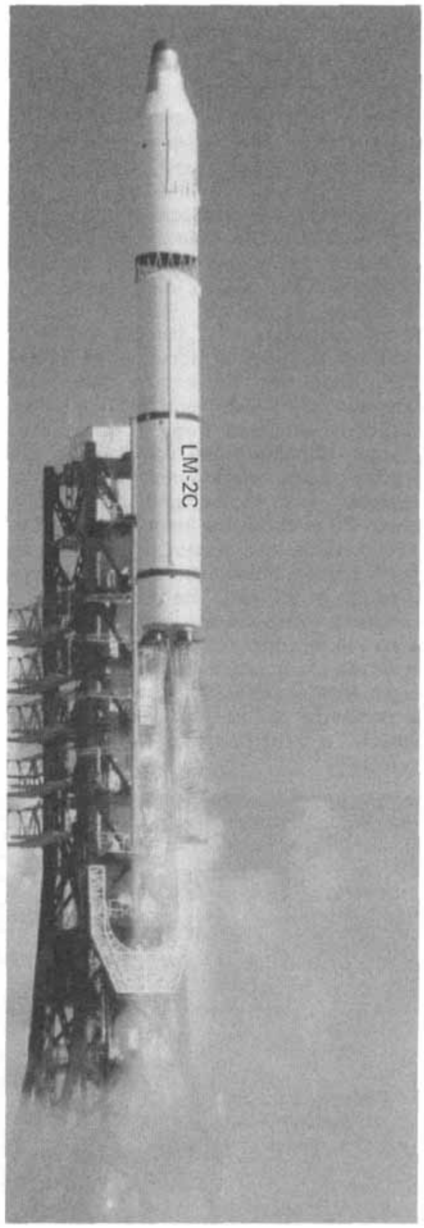
A parade in Beijing with left CSS-3 (DF-4) and right CSS-4 (DF-5) ballistic missiles
(Xinhua News Agency) 0003127

Dimethyl Hydrazine (UDMH) and nitrogen tetroxide, and provide a total thrust of 280 tonnes. The second stage consists of a single YF-22 engine giving 70 tonnes of thrust and a cluster of four small vernier engines gimbaled for guidance, each producing just over 1 tonne in thrust. The CSS-4 has a payload of 3,000 kg, which would be adequate for it to carry any of the nuclear warheads that have been tested by the PRC. The nuclear warhead is believed to have a yield of between 1 and 3 MT. Chaff and lightweight exoatmospheric decoys are also carried in the payload, with the payload assembly separating from the second stage after burnout of the motor. CSS-4 is believed to have a minimum range of 3,500 km and a maximum range of 12,000 km. The accuracy is estimated at 800 m CEP.

The improved DF-5A version has a payload increased to 3,200 kg and a maximum range of 13,000 km. It is possible that some DF-5A missiles have been modified to carry four or six MIRV, with nuclear warheads having a yield of 150 to 350 kT each. It is estimated that the accuracy of DF-5A is 500 m CEP.

Operational status

It is believed that the CSS-4 (DF-5) entered service in 1981 after a series of test launches conducted in 1979 and 1980. The improved DF-5A entered service in 1986. The USA has reported that CSS-4 missiles were deployed in hardened silos at two sites in central China in 1980-81, with between 4 and 10 launchers now operational. The launch sites are at Luoning and Xuanhua, and it is believed that further missiles are stored at Jiuquan and Wouzhai. The Great Wall project modernised DF-5/-5A missile basing facilities between 1985 and 1995, in the Tai-hai mountain range between the Hebei and Shanxi provinces. Some DF-5A missiles are reported to be stored horizontally in tunnels under the mountains. There are conflicting reports on the numbers of CSS-4 missiles that have been built, ranging from 20 to 50, due to the commonality between these missiles and the similar space launch vehicles. The Chinese are reported to have built a total of 24 silos and decoys, and as the LM-2C launch vehicles share common assemblies with the ballistic missiles, it is difficult to determine an accurate ballistic missile count. The original production facility for DF-5 missiles and LM-2 space launch vehicles was located at Wanyuan, south of Beijing, but production was transferred to an underground facility in Chengdu province in 1998. A report in 1992 stated that five DF-5 missiles were upgraded to the OF-5A standard, and a further report in 1998 stated that eight new DF-5A missiles had also been built. It is believed that between 20 and 30 DF-5/5A missiles are in service or in storage. It is expected that the DF-5 missiles will start to be taken out of service from around 2005, and replaced by the solid propellant DF-41 missile system.



The Long March-2C civilian space launcher, the workhorse of the Chinese satellite programme

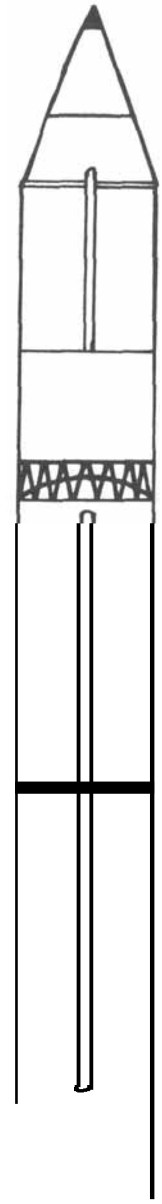


Diagram of the CSS4 (DF-5) inter-continental-range ballistic missile

Specifications

DF-5
Length: 32.6 m
Body diameter: 3.35 m
Launch weight: 183,000 kg
Payload: Single warhead, 3,000 kg
Warhead: Nuclear 1-3 MT
Guidance: Inertial
Propulsion: 2-stage liquid
Range: 12,000 km
Accuracy: 800 m CEP

DF-5A
Length: 32.6 m
Body diameter: 3.35 m
Launch weight: 183,000 kg
Payload: Single warhead or 4 to 6 MIRV, 3,200 kg
Warhead: (single warhead) nuclear 1-3 MT, or (MIRV) nuclear 150-350 kT each
Guidance: Inertial
Propulsion: 2-stage liquid
Range: 13,000 km
Accuracy: 500 m CEP

Contractor

It is believed that the DF-5 was designed by the First Academy of the Ministry of Aerospace Industries, now called the China Aerospace Industry Corporation, Beijing. The LM-2C satellite launch vehicle is now manufactured by the Chinese Academy of Launch Vehicle Technology (CALT) with final tests at the Wanyuan Industry Corporation, Beijing, and marketed by the China Great Wall Industry Corporation (CGWIC).

CSS-5 (DF-21)

Type

Intermediate-range, road mobile, solid-propellant, single warhead ballistic missile.

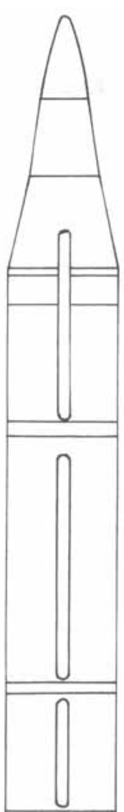
Development

The Chinese designated DF-21 (East Wind-21), intermediate-range ballistic missile has the NATO designation CSS-5, and is a variant of the CSS-N-3 (JL-1) submarine-launched ballistic missile developed from the mid-1960s and first test launched in 1982. The road mobile CSS-5 was first successfully test flown in 1985, and the missile is a replacement tactical nuclear missile for the liquid-fuelled CSS-1 (DF-2). CSS-5 was China's first road mobile solid-propellant ballistic missile. An improved version of CSS-5 Mod 2, known in China as DF-21A, has been developed with an increased range and several different warhead options. Reports in 1996 indicated that DF-21A had an improved accuracy; using both GPS and a radar-based terminal guidance system.

Description

CSS-5 (DF-21) is a two-stage solid-propellant missile with a length of 10.7 m, a body diameter of 1.4 m and a launch weight of 14,700 kg. It is believed that this missile probably has a single 250 kT nuclear warhead within its 600 kg payload, and that the warhead assembly separates from the second stage after motor burnout. The Chinese carried out seven tests of nuclear warheads between 1966 and 1983 with yields in the region of 150 to 350 kT, and it is assumed that this warhead was selected for DF-21. In the early 1990s there were reports that a conventional high-explosive warhead had been developed, and it is believed that submunition and chemical warheads are also available. The Chinese describe the guidance as inertial with an onboard computer. The CSS-5 missiles have a minimum range of 600 km and a maximum range of 2,150 km. CSS-5 is believed to have an accuracy of 700 m CEP. There are no known differences between the DF-21 and JL-1 missiles. CSS-5 is launched from a Transporter-Erector-Launcher (TEL) vehicle with the missile being cold-launched from its canister, with motor ignition occurring about 20 m above the launch vehicle. The TEL consists of a tractor vehicle and an open flat-top trailer with a single launch platform at the rear. The missile test and targeting functions are carried out from separate logistics and command vehicles. A six vehicle convoy is used by PLA artillery regiments for the CSS-5 system, including a command vehicle, a logistics support vehicle, a reload vehicle and three TEL vehicles.

CSS-5 Mod 2 (DF-21A) has a redesigned nose section, with a straight ogival shape. The missile has a length of 12.3 m, a body diameter of 1.4 m and a launch weight of around 15,200 kg. The warhead weight is believed to be 500 kg with several types of warhead that can be fitted, including nuclear, unitary high explosive, chemical, submunitions and also an EMP warhead to disable electronic components. The nuclear warhead is believed to be around 90 kT, although it could have a selectable yield varying between 20, 90 or 150 kT. The Chinese made 11 nuclear tests between 1983 and 1996 with yields between 20 and 150 kT. The DF-5A version is reported to have GPS updates and a radar correlation terminal guidance system, providing an accuracy in the region of 50 m CEP. The minimum range is believed to be 500 km and the maximum range 2,500 km. A new TEL vehicle was displayed in 1999, with a tractor-trailer unit having three axles on the tractor vehicle and three axles on the trailer. The missile was carried in a sealed canister, with several access hatches to provide for maintenance and testing.



A line diagram of the CSS-5 (DF-21) missile©

A new version CSS-5 Mod 2 (OF-2 IA) transporter-erector-launcher vehicle displayed in Beijing in October 1999 (A Pinkov) 0062805

An early standard CSS-5 ballistic missile transporter-erector-launcher vehicle. 0003128

Operational status

CSS-N-3 (JL-1) became operational in 1983, and it is believed that CSS-5 (DF-21) became operational in 1987 with the improved DF-21A operational in 1996. CSS-5 is reported to have ceased production in 1998, but there are no known exports. It is believed that between 35 and 50 missiles were in service in 1994, but that a total of 50 to 100 missiles had been completed by 1998. The missiles are believed to be deployed to six sites; Chuxiong (near the Burmese border), Datong (near Haiyan), Jianshui (near the Vietnamese border), Lianxiwang (adjacent to Taiwan), Tai-hai mountain range, and Tonghua (near the North Korean border). Reports in 1997 suggested that Saudi Arabia was examining possible options for replacing the CSS-2 (DF-3) missiles bought from China in 1987, and the DF-21A might be considered as a suitable replacement.

A CSS-N-3 (JL-1) missile shown on parade in Beijing in 1984 The CSS-5 (DF-2 l) missile is very similar and probably has the same external appearance

Specifications

CSS-5 (DF-21)
Length: 10.7 m
Body diameter: 1.4 m
Launch weight: 14,700 kg
Payload: Single warhead; 600 kg
Warhead: 250 kT nuclear, HE, submunitions or chemical
Guidance: Inertial
Propulsion: 2-stage solid propellant
Range: 2,150 km
Accuracy: 700 m CEP

CSS-5 Mod 2 (DF-21A)
Length: 12.3 m
Body diameter: 1.4 m
Launch weight: 15,200 kg
Payload: Single warhead, 500 kg
Warhead: 90 kT or selectable between 20, 90 and 150 kT nuclear, HE, chemical, submunitions or EMP
Guidance: Inertial with GPS and radar correlation
Propulsion: 2-stage solid propellant
Range: 2,500 km
Accuracy: 50 m CEP

Contractor

It is believed that development was by the First Academy of the Ministry of Aerospace Industries, now called the China Aerospace Industry Corporation, Beijing. Final test was at the Wanyuan Industry Corporation. Beijing

CSS-6 (DF-15/M-9)

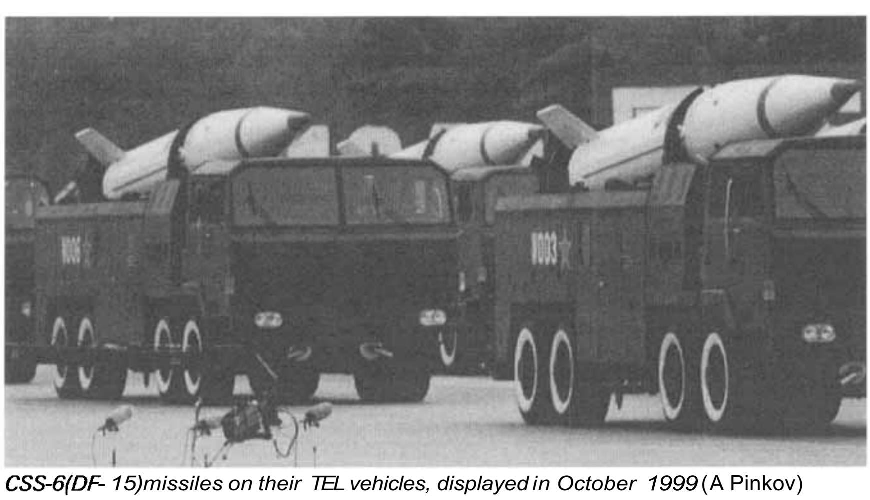
Type
Intermediate-range, road mobile, solid-propellant, single warhead ballistic missile.

Development
The development of the M family of solid-propellant short- and intermediate-range ballistic missiles is believed to have started in 1984, to be built for export and to have conventional HE warheads. There have been reports of four missiles in this family, known in China as M-7, M-9, M-11 and M-18. M-7 is believed to be the designator for CSS-8, a modified solid-propellant SRBM derived from the old Russian SA-2 'Guideline' SAM design (known as HQ-2 in China). It is believed that the M-9 and M-11 programmes were developed by different design teams, with M-9 designed for Syria and M-11 designed for Pakistan. M-9 has a range of 600 km, and was adopted during development by the Chinese PLA, having the Chinese internal designator DF-15 and the NATO designator CSS-6. The M-11 missile was developed as a solid-propellant interchangeable version of the SS-1 'Scud', capable of fitting the former Soviet MAZ 543 Transporter-Erector-Launcher (TEL) with the minimum of modification. M-11 has a range of 350 km, and was also adopted by the Chinese PLA, having the Chinese internal designator DF-11 and the NATO designator CSS-7. The fourth member of the M family, M-18, was shown at an exhibition in Beijing in 1988, and appeared to be a larger two-stage version of the M-9 missile. It is possible that the M-18 design was demonstrated in Iran in 1991, but it is believed that the M-18 design was not continued in China. The first flight test of M-9 was made in June 1988, and development was completed in 1990. A report in 1996 suggested that the Beijing Research Institute for Telemetry had completed the development of a terminal guidance improvement to the CSS-6 missile, believed to include a GPS/INS system, and this version has been designated CSS-6 Mod 2 or DF-15A.


A CSS-6 (DF-15/M-9) ballistic missile at launch from its wheeled TEL in March 1996 (Xinhua News Agency)
0003129


This picture is believed to show a CSS-6 (DF-15/M-9) missile

Description
The CSS-6 missile is reported to be 9.1 m long, to have a body diameter of 1.0 m and a launch weight of 6,200 kg. The missile has strapdown inertial guidance with an onboard digital computer. This enables rapid targeting and eliminates the need for wind corrections prior to launch. As an accuracy of 300 m CEP has been suggested, some form of terminal guidance must be employed. An unconfirmed report states that the separating warhead section has a miniature propulsion system to correct attitude before re-entry, as well as adjusting the terminal trajectory. The warhead weight is believed to be 500 kg and it is believed that an HE warhead was included in the original design. However, subsequent reports indicate that, in Chinese service, DF-15 can have a nuclear warhead option with a yield of around 90 kT. The Chinese tested 11 nuclear warheads between 1983 and 1996 with a yield in the 20 to 150 kT range, and it is possible that a warhead with a selectable yield between 20, 90 and 150 kT is also available for this missile. Further reports indicate that both chemical and submunition warheads have been developed. There has also been a report of a fuel-air explosive warhead. CSS-6 has a minimum range of 50 km and a maximum range of 600 km, and has a single-stage solid-propellant motor. The motor casing is believed to be made from carbon composite. With a warhead reduced to 320 kg, this missile could have a range of up to 800 km. Control during the boost phase could be by exhaust vanes or small vernier motors. The missiles are transported on a four axle wheeled TEL vehicle, with the missile raised to the vertical before launch. From the size and weight of the missiles, a common TEL could be used by both CSS-6 and CSS-7


CSS-6 (DF-15) missiles on their TEL vehicles, displayed in October 1999 (A Pinkov)
0062807

missiles. Earlier pictures showed a TEL with clam-shell doors on top to protect the missiles in cold weather, but the more recent TEL displayed in 1999 was different and did not appear to have any doors.

A CSS-5 Mod 2, DF-15A missile is believed to have included GPS updates and a radar terminal correlation system to reduce the CEP to 30 to 45 m. A radar proximity fuze is also included in this upgrade. This version has been seen with a third type of TEL vehicle. which has a single door that closes over the top of the missile when the missile is in the horizontal carrying position, for improved environmental control. An electro-magnetic pulse warhead option has also been reported. The PLA Second Artillery is reported to have completed construction of CSS-6 bases on a country-wide basis in the 'Great Wall' project, which began in 1985 and was completed in 1995.

Operational status

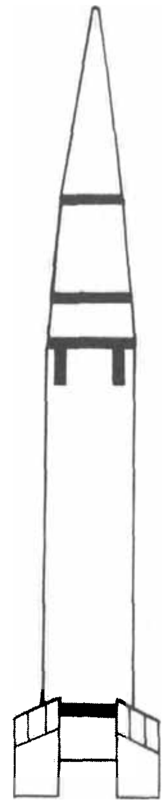
The first flight test of the CSS-6 was reported to have occurred in June 1988, and it is believed that the missile probably entered service around 1990. The CSS-5 Mod 2 missiles entered service in 1996. A typical missile brigade has 16 TEL and around 100 missiles, with all the equipment stored underground. There were reports that Syria was negotiating to buy M-9 missiles in 1988, followed by reports that Libya purchased 140 M-9 missiles in 1989 and passed 80 of these on to Syria. There are also reports that M-9 missiles or their technologies may have been sold to Egypt, Iran and Pakistan. In 1997 it was reported that Serbia had ordered some M-9 missiles. However, there has as yet been no confirmation that any of these orders were met by deliveries from China and at present there are still no confirmed exports of the M-9 missile. China test launched six CSS-6 missiles into the sea near Taiwan in July 1995, with one missile having an in-flight failure. A further four missiles were launched towards Taiwan in March 1996. The total number of CSS-6 missiles in service in China was estimated to be around 300 at the end of 1998, but the missiles are still in production and the final planned figure is reported to be 650 missiles. Main bases are reported to be located at Leping and Xang Rau in Jiangxi province, at Jiaingshan in Zhejiang province, and also at Xau Wu and Yongau in Fujian province.

Specifications

Length: 9.1 m
Body diameter: 1.0 m
Launch weight: 6,200 kg
Payload: Single warhead; 500 kg
Warhead: HE, nuclear 90 kT, chemical, EMP, or submunitions
Guidance: Inertial with terminal control
Propulsion: Solid propellant
Range: 600 km
Accuracy: 300 m (DF-15) or 30-45 m (DF-15A) CEP

Contractor

It is believed that the CSS-6 was designed by the First Academy of the Ministry of Aerospace Industries, now called the China Aerospace Industry Corporation, Beijing. Final tests were made by the Wanyuan Industry Corporation, Beijing. The system has been marketed by China National Precision Machinery Import and Export Corporation (CPMIEC).



A line drawing of the CSS-6 (M-9/DF-15) missile 0062806

CSS-7 (DF-11/M-11)

Type

Short-range, road-mobile, solid-propellant, single warhead ballistic missile.

Development

The development of the M family of solid-propellant short- and intermediate-range ballistic missiles is believed to have started in 1984, to be built for export and to have conventional HE warheads. There have been reports of four missiles in this family, known in China as M-7, M-9, M-11 and M-18. M-7 is believed to be the export designator of the missile project known as 8610, which converted the HQ-2 surface-to-air missile (a Chinese copy of the Russian SA-2 'Guideline') into a ballistic missile with a range of 150 km. This missile has the NATO designator CSS-8. It is believed that the M-9 and M-11 programmes were developed by different design teams, with M-9 designed for Syria and M-11 designed for Pakistan. M-9 has a range of 600 km, and was adopted during development by the Chinese PLA, having the Chinese internal designator DF-15 and the NATO designator CSS-6. The M-11 missile was developed as a solid-propellant interchangeable version of the SS-1 'Scud B', capable of fitting the former Soviet MAZ 543 Transporter-Erector-Launcher (TEL) with the minimum of modification. The MAZ 543 vehicle can be modified by rearranging the launcher cradle and roof assemblies, to carry different length and diameter missiles. There are no known Russian developments of a solid-propellant 'Scud B' version, and it is assumed that the Chinese objective was to compete directly with the 'Scud B' for exports. M-11 was reported to have a range of 280 km, which kept it below the limits of the Missile Technology Control Regime (MTCR). The missile was also adopted by the Chinese People's Liberation Army (PLA), being given the Chinese internal designator DF-11 and the NATO designator CSS-7, and this version is believed to have a longer range. The fourth member of the M family, M-18, was shown at an exhibition in Beijing in 1988, and appeared to be a larger two-stage version of the M-9 missile. However, apart from a possible demonstration flight in Iran in 1991, it is believed that the M-18 programme was teminated in China in 1992. An improved version, known as CSS-7 Mod 2 or DF-11A, was reported in 1998 with a longer nose assembly and an increased range.

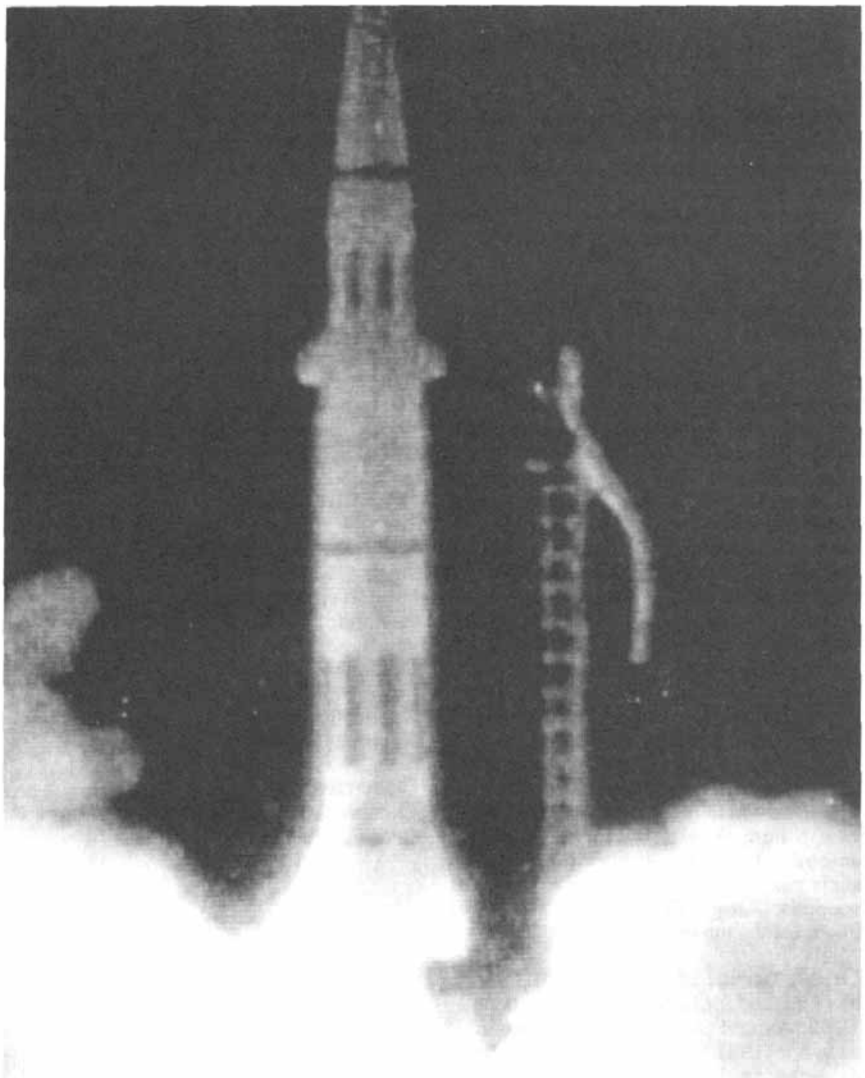
A new wheeled TEL vehicle for the CSS-7 missile, displayed in Beijing in 1999 (via IDR)
NEW/0059919

Description

Little detail is known about the CSS-7, except that it is believed to be a solid-propellant missile with external dimensions and electrical interface similar to the former Soviet SS-1 'Scud B' missile, but considerably shorter and lighter. It is believed that the warhead assembly separates in flight, and there are four small control fins mounted at the rear of this warhead section. It is not known if these four fins move, or are simply stabilisers. However, the fins might indicate that there is terminal control. Control during the boost phase may be by vanes in the exhaust or small vernier motors, with an inertial platform for guidance. A photograph of a model of the missile was shown in Beijing in 1988, showing the missile on a MAZ 543 TEL. It is believed that the missile is 7.5 m long and has a body diameter of 0.8 m. A launch weight of about 3,800 kg has been estimated. The Chinese originally suggested that the M-11 warhead was 500 kg in the CSS-7 missile, and that the missile had a minimum range of 120 km and a maximum range of 300 km. However, subsequent reports indicated a warhead weight of 800 kg, with a range reduced to 280 km. It is possible that both sets of figures are correct, as variants could be developed with different warhead/propellant weight ratios; particularly because of the sensitivity of the 500 kg warhead/300 km range limitation of the MTCR.. Initially developed with an HE warhead for export as the M-11 missile, it is reported that the DF-11 version in service in China has an optional nuclear warhead which has a selectable yield of 2, 10 or 20 kT. In addition, it is believed that submunition, fuel-air explosive and chemical warheads have also been developed for CSS-7, with one report suggesting that the payload could be up to 100 × 5 kg submunitions. A terminal guidance system has also been suggested, probably similar to that used on CSS-6, with a miniature propulsion system in the separating warhead section to correct the attitude before re-entry, as well as the trajectory. Reports from the US suggest that the DF-11 version has a maximum range of 350 km.

The improved CSS-7 Mod 2 (DF-11A) missile was first reported in 1998 and has a longer and smaller diameter warhead

A picture of a model of the M-11 (CSS-7/DF-11) missile on a MAZ 543 TEL, shown in Beijing in 1988 (Christopher F Foss)

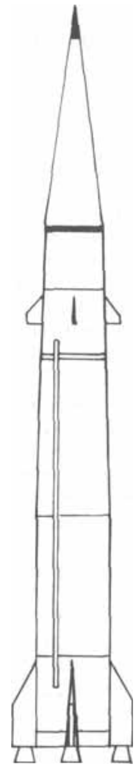


*A CSS-7 **ballistic missile at launch*** 0003130

assembly, probably with GPS updates to improve the terminal accuracy The length of this version is believed to be around 8 5 m, the body diameter 0 8 m and the launch weight 4,200 kg It is not known if the Chinese have reduced the payload weight and increased the range, but some unconfirmed reports suggest a payload of 500 kg and a maximum range of 350 km with an accuracy of 200 m CEP An unconfirmed report states that an optical correlation terminal guidance system has been fitted as well as INS/GPS, and that this version has an accuracy of 20 to 30 m CEP US reports suggest a maximum range of 400 or 530 km In 1999, a new TEL was displayed for the CSS-7 missiles, which appeared to be a conversion of a four-axle military truck

Operational status

The first flight test of the CSS-7 was reported to have occurred in 1990 and it is believed that the missile probably entered service in 1992 The improved CSS-7 Mod 2 version is believed to have entered service in 1998 Unconfirmed reports suggest that trial results indicated less accuracy with the terminal guidance system, and that *600* m CEP was the best that could be achieved by the initial standard CSS-7 missiles. It is believed that China had around 200 missiles in service in 1997. and that the total may now be 300. The missiles were manufactured at the Sanjiang Missile Group in Yuanan, some 210 km west of Beijing. Main bases for these missiles are located at Yongan and Xianyou in Fujian province. There are reports that some M-11 missiles and/or assemblies were sold to Pakistan and Iran, but these have been denied by China. The reports suggest that about 30 missiles were exported to Pakistan in 1993 together with 15 TEL vehicles, but that the missiles were retained in storage cases at Sargodha Air Base near Lahore. Pakistan is believed to have built a solid propellant missile manufacturing capability with Chinese assistance. Pakistan tested a new missile, designated Ghaznavi or Hatf 3, in May 2002, and this appeared to be similar to the M-11. Pakistan stated that this missile has a range of 290 km, and it was probably the first test of the M-11 missiles sold to Pakistan, or of licence-built missiles based on the M-11 design. The Pakistan Shaheen 1 missile, first test flown in April 1999, appears to be a scaled-up version of the Chinese M-11 design but with a



*A **line drawing of the** CSS-7 (DF-11/M-11) **missile***

maximum range of between *600* and 750 km. The Shaheen 2 missile appears to have a new first stage, but to use a Shaheen 1 missile as the second stage. A further 30 to 50 M-11 missile assemblies and TEL were reported to have been delivered to Iran in 1995 with the objective of setting up a final assembly and, later, a full production capability. However, there has been no confirmation of this reported sale to Iran.

Specifications

***CSS-7* (DF-11)**
Length: 7.5 m
Body diameter: 0.8 m
Launch weight: 3,800 kg
Payload: Single warhead; 800 kg
Warhead: **HE,** nuclear 2, 10 or 20 kT, submunitions, FAE or chemical
Guidance: Inertial with terminal control
Propulsion: Solid propellant
Range: 280 to 350 km
Accuracy: *600* m CEP

CSS-7 Mod 2 **(DF-11**A)
Length: 8.5 m
Body diameter: 0.8 m
Launch weight: 4,200 kg
Payload: Single warhead, 500 kg
Warhead: HE, nuclear 2.10 or 20 kT, submunitions, FAE or chemical
Guidance: Inertial with GPS and terminal control
Propulsion: Solid propellant
Range: 350 to 530 km
Accuracy: 200 m CEP

Contractor

It is believed that CSS-7 was designed by the Base *066* Division (formerly part of the Third Academy) of the Ministry of Aerospace Industry, but it has been marketed by CPMIEC, Beijing.

CSS-8 (M-7/Project 86I 0)

Type

Short-range, road-mobile, solid-propellant, single warhead ballistic missile.

Development

The development of the M family of solid-propellant short- and intermediate-range ballistic missiles is believed to have started in 1984, to be built for export and to have conventional HE warheads. There have been reports of four missiles in this family, known in China as M-7, M-9, M-11 and M-18. M-7, is believed to have been the designator for an export version of the missile project known as 8610, which converted the HQ-2 Surface-to-Air Missile (SAM) into a ballistic missile. The Russians sold some SA-2 'Guideline' SAMs to China in the late 1950s. and the Chinese either reverse-engineered or built under licence the Hang Qi-1 (HQ-1) between 1961 and 1964. The Chinese then developed an improved version, designated HQ-2, which entered service in 1967. The HQ-2 SAM programme is believed to have started around 1985 and the missile probably entered service in 1992. M-7 has been given the NATO designator CSS-8. It is not known if the Chinese still use the project 8610 designator for this missile in service. M-9 is a solid-propellant missile with a range of 600 km, being given the Chinese internal designator DF-15 and the NATO designator CSS-6. The M-11 missile was developed as a solid-propellant interchangeable version of the SS-1 'Scud B', capable of fitting the former Soviet MAZ 543 Transporter-Erector-Launcher (TEL) with the minimum of modification. M-11 has a range of 350 km, and was also adopted by the Chinese People's Liberation Army (PLA), being given the Chinese internal designator DF-11 and the NATO designator CSS-7. The fourth member of the M family, M-18, was shown at an exhibition in Beijing in 1988 and appeared to be a larger two-stage version of the M-9 missile. It is believed that the M-18 programme was terminated in 1992.

Description

It is believed that CSS-8 is a modified SA-2 'Guideline'/HQ-2 surface-to-air missile. The CSS-8 design is based on HQ-2B. which is fitted to a tracked launcher vehicle developed from the Type 63 light tank chassis. The liquid-propellant sustainer motor of the HQ-2B missile has been replaced with a solid-propellant motor, creating a two-stage solid-propellant ballistic missile. The missile is believed to be 10.8 m long, to have a first-stage body diameter of 0.65 m and a second-stage body diameter of 0.5 m. The CSS-8 weighs 2,650 kg at launch and has a 190 kg HE warhead. There are probably alternative submunition and chemical warheads. Guidance is inertial, possibly with command updates during the boost phases. Control is provided by four moving fins, located at the rear of the second-stage assembly. The solid boost motor is an improved version from the HQ-2 design, with a burn time of 4 seconds, and this assembly is jettisoned after burnout. The sustainer motor burns for 20 to 30 seconds, giving CSS-8 a minimum range of 50 km and a maximum range of 150 km.

Operational status

It is believed that CSS-8 entered service in 1992. Around 90 missiles were exported to Iran in 1992, and some may have been exported to Iraq. There may be some connection between the CSS-8 programme in China and the North Korean development of an SA-2 'Guideline' short-range ballistic missile, although the North Korean development is believed to have been terminated. Several other countries have adapted former Russian SA-2 'Guideline' missiles into ballistic missiles, notably Iran, Croatia and Serbia. However, it is difficult to determine if these are exported M-7 missiles, simply adaptations of the SAM variant or copies of the CSS-8 (M-7) design. The total number of HQ-2 SAM missiles built in China is believed to be around 5,000 and it is possible that 100 to 500 may have been converted into the CSS-8 ballistic missile variant.

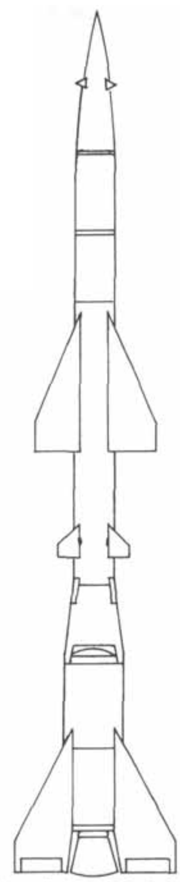
Specifications

Length: 10.8 m
Body diameter: 1st-stage 0.65 m, 2nd-stage 0.5 m
Launch weight: 2,650 kg
Payload: Single warhead; 190 kg
Warhead: HE, submunitions, chemical
Guidance: Inertial with command updates
Propulsion: 2-stage solid propellant
Range: 150 km
Accuracy: n/k

Contractor

Chinese State Factories; but marketed by CPMIEC, Beijing.

This picture shows a HQ-2 SAM on its tracked launcher vehicle and it is believed that the CSS-8 short-range ballistic missile is similar in appearance



A line drawing of the CSS-8 (M-7)

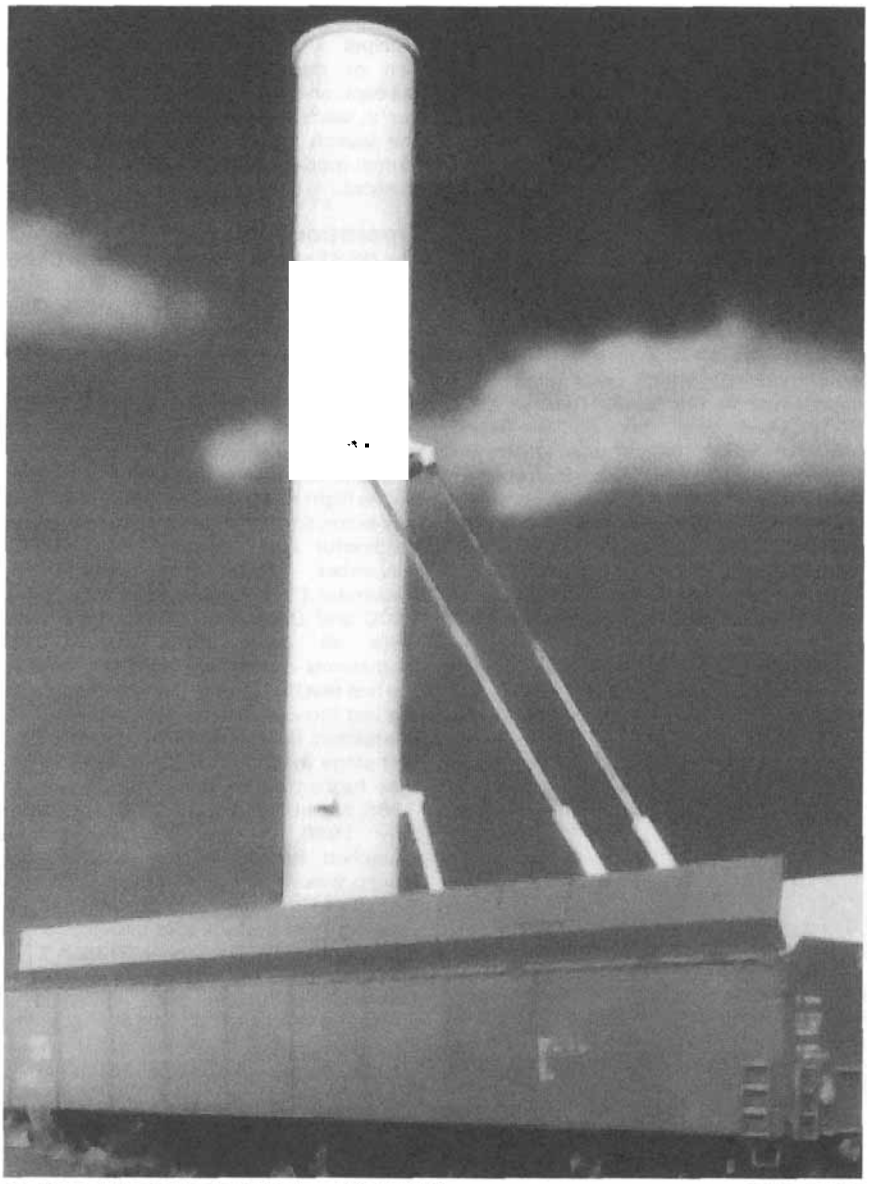
CSS-9 (DF-31)

Type

Inter-continental range, road/rail-mobile, solid propellant, single warhead or MIRV-capable ballistic missile.

Development

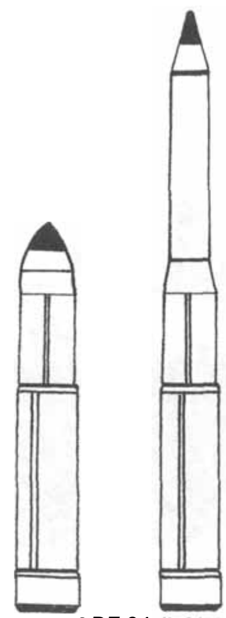
The Chinese are believed to have started the design and development of the Ju Lang-2 (JL-2) submarine-launched ballistic missile, together with its land-based version the Dong Feng-23 (DF-23) in 1970. These two missiles were to have had a range of 6,000 km and a payload of 800 kg to carry a single second-generation nuclear warhead. In 1985 the operational requirement was changed, probably because the second-generation warheads could be built smaller than expected and the payload was reduced to 700 kg. The range was increased to 8,000 km, and the Chinese decided to place the priority on the land-based version, which was designated Dong Feng-31 (DF-31). The change was probably made to replace the ageing CSS-3 (DF-4) missiles in the late 1990s. a requirement that fell before the expected in-service date of the second-generation SLBM version, the JL-2, due to the delays in the Type 094 nuclear submarine programme. The design and development for the DF-31 and JL-2 missiles has been managed by the First Academy of the Ministry of Aerospace Industries, now called the China Aerospace Industry Corporation, Beijing. The flight test programme has been managed by the 2nd Artillery Corps, based at the Wuzhai test centre in Shanxi province. The first test firing of a 2.0 m diameter solid-propellant motor was made in 1983, and the first successful flight test of a DF-31 missile was made in 1995 from the Wuzhai test centre. It is believed that the NATO designator for the DF-31 missile is CSS-9. There are reported to be five build standards for the DF-31 missile; Mod 0 was the initial trials standard, Mod 1 is the road mobile version, Mod 2 the silo launch version, Mod 3 the off-road version, and Mod 4 the rail-car launched version. Some missiles have been tested with decoys and penetration aids, and it is reported that a single nuclear warhead or up to five MIRVs may be fitted. There are unconfirmed reports that the DF-25 programme, to develop a missile with a range of 2,500 km, has been re-started, and that this missile will use the first two stages of the DF-31. It was also reported that DF-41 uses the first two stages of DF-31, with a lengthened third stage, to develop a missile with a range of 12,000 km or greater. However, it is now believed that the DF-41 is a new design. There have been two TEL vehicles developed for the DF-31 project, one using a commercial tractor and trailer combination, which was displayed in 1999, and the other using a wheeled cross-country capable vehicle based on earlier Russian TEL designs. In addition, a rail-car launcher system is being developed, and is expected to enter service in 2003. In 2001 an unconfirmed report suggested that an upgraded DF-31A version was being developed, with a range increased to 10,000 km. This version uses a lengthened third stage, and may use future navigation satellites to improve its accuracy. There are also reports that manouevrable RVs are being developed, to evade defence systems. The basic DF-31 missile has been developed as a satellite launch vehicle, to put payloads of 100 to 300 kg into low earth orbit, and this version was initially designated SLV-1. In November 2001 the Chinese displayed a model of the Kaituozhe-1 (KT-1) satellite launch vehicle, which appeared to be similar to the DF-31A, as it was a three stage solid propellant launch vehicle. This was flight tested in January 2002.



A rail-car launcher, being developed for DF-31 ***NEW***/0059915

Description

There are only a few details known about the DF-31 missile. It has three



Line diagrams** of DF-31 (left) and DF-31A (right)* ***NEW/0137928

solid-propellant stages that are believed to have a 2.0 m body diameter, and the maximum range is 8,000 km. The remaining specifications have been estimated from the launch canister sizes, and the known carrying capabilities of the TEL vehicles. It is believed that the DF-31 missile has a length of 13.0 m, a body diameter of 2.0 m, and a launch weight of 42,000 kg. The separating warhead assembly is thought to carry a payload weight of 1,050 to 1,750 kg, with a single nuclear warhead having a yield of 1 MT. Alternative payloads have been developed with a new bus using liquid propellants, including three to five MIRV warheads with selectable yields of 20, 90 or 150 kT and penetration aids. China has conducted 11 tests of nuclear warheads in the range 20 to 150 kT between 1983 and 1996, and it is probable that these tests were to prove the smaller designs for carriage on the DF-31 and JL-2 missiles, if required. The smaller warheads are reported to be similar to the US designed W88. The MIRVs would then be around 1.75 m long, have a base diameter of 0.55 m, and weigh 250 to 300 kg each. Reports from the USA indicate that countermeasures have been included in four of the DF-31 flight tests between 1995 and 2001, and that the May 1995 test included three MIRV nuclear warheads with a yield of between 50 and 90 kT each. It is reported that the First Academy's 13th Institute (Inertial Navigation) was researching star trackers to provide guidance updates since the mid-1970s. and it is expected that stellar navigation and GPS updates will be used in the DF-31 design to improve accuracy over the full range capability. An accuracy of around 300 m CEP is expected, although reports have suggested 100 m CEP for the silo launched version and 150 m CEP for the TEL launched missiles. The missiles are stored, transported and launched from a canister, with a solid propellant gas generator in the base of the canister providing a cold launch. The first stage solid propellant motor is ignited after the missile clears the canister, so that the canister can easily be re-used. It is believed that the minimum range of DF-31 will be around 2,000 km, and the maximum range 8,000 km.

A DF-31 TEL vehicle displayed in Beijing in October 1999 (A Pinkov) 0062808

An upgraded DF-31A version is reported to be in development, with a range increased to 10,000 km. This version is believed to have a length of 18.4 m, and a launch weight of 47,200 kg. The third stage has been lengthened by 5.4 m, and it is possible that this version has fewer MIRV warheads or just a single warhead.

It is expected that the Chinese will store the DF-31 missiles in caves, but that they will be road mobile on wheeled Transporter-Erector-Launcher (TEL) vehicles, carried in specially adapted rail-cars, or placed in silos. The DF-31 missiles displayed in October 1999 were carried in canisters mounted on an articulated tractor and trailer vehicle, with four axles on each tractor and each trailer, and similar to the DF-21A TELs displayed at the same time. These are believed to be limited to main roads, and have a maximum speed of 60 km/hr. In 2001 a new wheeled TEL was reported, which was similar in appearance to the former Russian MAZ 547V used with the SS-20 'Saber' (RSD-10) IRBM, which was destroyed following the 1987 INF treaty. It is reported that the Sanjiang Special Vehicle Technology Centre may have developed this new TEL, based on civil vehicle technologies. The new six-axle TEL is believed to have a load capability of 50,000 kg, a V58-7-MS diesel engine developing 533 kW power, a length of 16.5 m, a width of 3.0 m, and a height unloaded of 3.1 m. It is possible that this TEL is required for the longer DF-31A version. This TEL is expected to have a road speed of around 40 to 45 km/hr. The rail-car launcher is expected to be similar to that used by the former USSR, SS-24 'Scalpel' (RS-22) missile system, with two or three engines, three launcher rail-cars, and a command and control rail-car in each train set. It is reported that the launch preparation time for all the launch modes will be between 10 and 15 minutes.

***The** second type of TEL, probably used for DF-31A, with cross-country capability* (Yihang Chang) ***NEW**/0059916*

Operational status

The DF-31 missile entered service in China in 1999, and is expected to be used to replace the CSS-3 (DF-4) missiles. The programme is closely related to the JL-2 SLBM, and the missiles are expected to be very similar. In addition, it is possible that the flight test programmes for DF-31, JL-2, and DF-25 have been integrated, as common stages are used in all these projects. There have been varying reports on the flight test programme for DF-31, but it is believed that there have been seven successful flight tests in May 1995, November 1995, January 1996. December 1996, August 1999, November 2000 and December 2000. These tests were all made from the Wuzhai (sometimes called Tai Yuan) test centre; the first test had three MIRV warheads, and the last three all carried countermeasures. In addition, there have been reports that a first stage motor test failed in April 1992, that further motor tests were made in 1995, two in 1996, one in 1997 and one in July 1999. A simulated Submarine-Launched Ballistic Missile (SLBM) cold launch was reported in October 1997 (to test the cold launch system only), and a possible land system cold launch from a silo was tested in December 1998. A KT-1 satellite launch vehicle, similar to DF-31, was used in January 2002 to launch a simulated payload of MIRVs, and US reports suggest that the third stage exploded or was deliberately broken up to mask the penetration aids being used in the test. It is not clear where the DF-31 missiles are built, as some reports suggest near to the Wuzhai test centre, but other reports suggest at Yangang, in the Sichuan

province. Final testing is carried out at the Wanyuan Industry Corporation, Beijing, and the missiles are then transported by rail to Wuzhai for flight testing. The Great Wall project, which took ten years to complete between 1985 and 1995, upgraded ICBM base facilities in the Tai-hai mountain range between Hebei and Shanxi provinces. It is believed that the DF-31 will be stored in caves in the mountains, and transported by TEL or rail-cars to various launch sites, using TEL, rail-car or silos launches. It was believed that between 10 to 20 operational missiles would be built in a first batch, but a further 70 to 80 JL-2 missiles may be built for the Type 094 submarines, and further DF-31 may be added later. Two regiments of DF-31 missiles are reported to be operational in southern and central China, with eight TELs each. If the KT-1 SLV programme proceeds, then it will be difficult to determine the Intercontinental Ballistic Missile (ICBM) numbers due to the close similarities between the Satellite Launch Vehicle (SLV) and ICBM.

Saudi Arabia has been reported to be examining possible replacement missiles for the liquid-propellant CSS-2 (DF-3) missiles bought in 1987, and the DF-31 might be an option although it would seem to have too great a range.

Specifications

Length: 13.0 m (31). 18.4 m (31A)
Body diameter: 2.0 m
Launch weight: 42,000 kg (31). 47,200 kg (31A)
Payload: Single warhead or 3 to 5 MIRV, 1,050 to 1,750 kg
Warhead: Nuclear 1 MT or 3 to 5 MIRV with selectable 20, 90 or 150 kT each
Guidance: Inertial with stellar updates
Propulsion: 3-stage solid propellant
Range: 8,000 km (31). or 10,000 km (31A)
Accuracy: 300 m CEP

Contractor

It is believed that DF-31 has been designed by the First Academy of the Ministry of Aerospace Industries, now called China Aerospace Industry Corporation, Beijing. Final testing is made at the Wanyuan Industry Corporation, Beijing. and the flight test programme has been carried out by the 2nd Artillery Corps at Wuzhai test centre.

CSS-X-10 (DF-41)

Type

Inter-continental range, road/rail mobile, solid propellant, single warhead or MIRV-capable ballistic missile.

Development

The Chinese are believed to have started the design and development of the Dong Feng-41 (DF-41) in 1986, with the operational requirement to have a solid-propellant, road mobile, ballistic missile with a range of 12,000 km to replace the CSS-4 (DF-5 and DF-5A) liquid-propellant missiles. The development for DF-41 is believed to be managed by the China Aerospace Industry Corporation, Beijing (was the First Academy of the Ministry of Aerospace Industries). The flight test programme is managed by the 2nd Artillery Corps, based at the Wuzhai test centre in Shanxi province. There has been one reported ground test and a simulated cold launch in October 1999, but no test flights to date, although a test was reported to have been in preparation in September 2001. Original reports stated that DF-41 used the first two stages of the DF-31, with a lengthened third stage, but it is now believed that this description referred to the DF-31A, and that the DF-41 is a new design. It is believed that the NATO designator will be CSS-X-IO. Reports in 1996 suggested that DF-41 would have between two and nine MIRV warheads, but it is possible that the initial build missiles will have provision for either a single warhead or six to ten MIRV. Unconfirmed reports in 1994 and again in 1996 suggested that the Chinese had been trying to obtain technologies from the Russian SS-18 'Satan', SS-24 'Scalpel' and SS-25 'Sickle' programmes, particularly advanced guidance capabilities. In 2001 both rail-car and cross-country TEL projects were noted for DF-31, and it is presumed that these might also be adapted later for DF-41. These launchers appeared to use a rail-car similar to that used with the SS-24, and a TEL similar to that used with SS-20 'Saber' and later SS-25.

Description

There are few details known about the DF-41 missile, and the specifications that follow are based on estimates. The missile has a length of around 21.0 m, and has three solid-propellant stages that are believed to have a 2.2 m body diameter. The launch weight is expected to be in the region of 80,000 kg, with a payload capability of 2,500 kg. It is expected to have alternative warhead fits using either a single 1 MT warhead, or six to ten MIRV with selectable yields of 20, 90 or 150 kT. The MIRV will probably be similar to those used on the DF-31, with a length of 1.75 m, a base diameter of 0.55 m, and weighing between 250 and 300 kg each. It is expected that DF-41 will carry countermeasures. It is reported that the 13th Institute (Inertial Navigation) has been researching star trackers to provide guidance updates since the mid-1970s. and it is expected that stellar navigation and GPS updates will be used in the DF-41 design to improve accuracy over the full range capability. The accuracy is expected to be between 100 and 500 m CEP. It is believed that the minimum range of DF-41 will be around 3,000 km, and the maximum range 12,000 to 14,000 km.

It is expected that the Chinese will store the DF-41 missiles in caves, but that they will be road mobile on wheeled transporter-erector-launcher vehicles or on rail-cars, and that the missiles will be launched from silos, TEL or rail-cars. At the October 1999 parade in Beijing, a new type of tractor-trailer vehicle was seen with four axles on each tractor and each trailer, and with the DF-31 missile in a launch canister mounted on the trailer. This TEL would be limited to main roads, and in 2001 a cross-country version was seen for DF-31, similar to the former USSR MAZ 547V TEL used with the SS-20 'Saber' IRBM system. It is expected that the Chinese will develop a larger cross-country TEL for use with DF-41, probably with seven axles, similar to the launcher used with the SS-25 ICBM. A rail-car launcher may also be developed for DF-41, similar to that used with the SS-24 ICBM.

Operational status

The DF-41 missile is expected to enter service in China from around 2005, and to be used to replace the CSS-4 (DF-5/-5A) liquid-propellant missiles. It is believed that some 10 to 20 missiles will be built initially, but that the final total will be 96 missiles, with around half in silos and the remainder mobile. Flight tests from the Wuzhai test centre are expected to start soon.

Specifications

Length: 21.0 m
Body diameter: 2.2 m
Launch weight: 80,000 kg
Payload: Single warhead or 6 to 10 MIRV, 2,500 kg
Warhead: Nuclear 1 MT or 6 to 10 MIRV with selectable 20, 90 or 150 kT each
Guidance: Inertial with stellar updates
Propulsion: 3-stage solid propellant
Range: 12,000 to 14,000 km
Accuracy: 100 to 500 m CEP

Contractor

It is believed that DF-41 is being designed and developed by the China Aerospace Industry Corporation, Beijing, with final testing at the Wanyaun Industry Corporation, Beijing. The flight testing will be managed by the 2nd Artillery Corps at Wuzhai test centre.

CSS-N-1 'Scrubbrush'(SY-1), CSS-N-2 'Safflower'(HY-1), CSSC-2 'Silkworm' (HY-1), CSSC-3 'Seersucker' (HY-2/ c-201)

Type

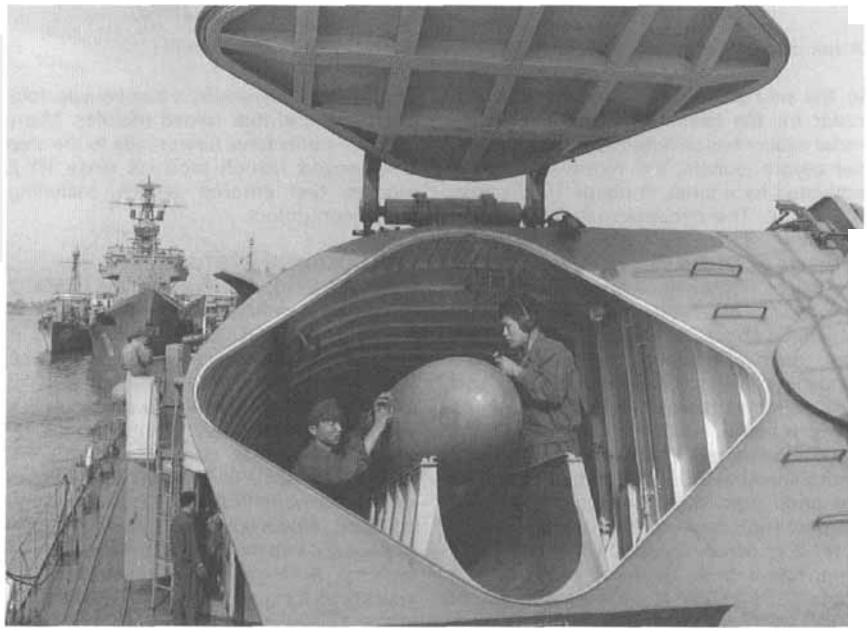
Short-range, ground- and ship-launched, liquid-propellant, single warhead surface-to-surface missiles.

Development

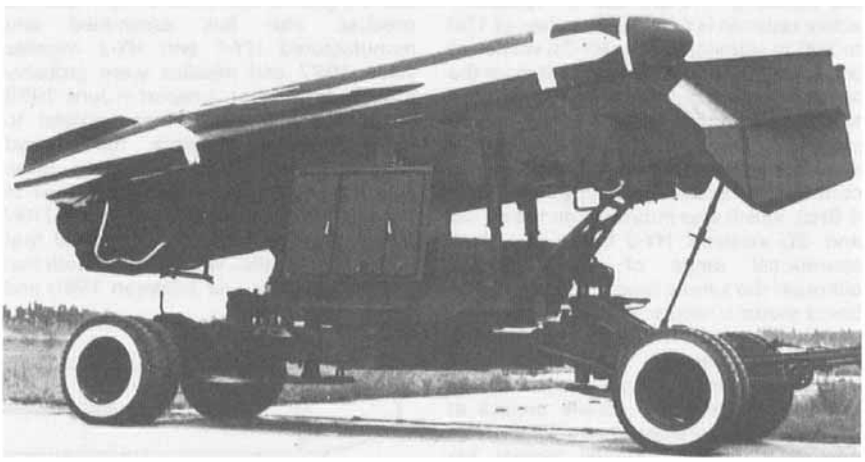
In the late 1950s the former USSR supplied China with a number of P-15 missiles, given the NATO designator SS-N-2A 'Styx'. The Chinese designated these Russian missiles SY-1 (NATO designator CSS-N-1 'Scrubbrush'), and they formed the baseline design for a major part of the Chinese missile inventory from the 1960s to the 1980s. During the late 1960s. the Chinese built their own version of the Russian 'Styx' and these were called Hai Ying-1 (HY-1). HY-1 was built as a ship-launched and coastal defence anti-ship missile, and although these missiles were identical, NATO gave separate designators allocating CSS-N-2 'Safflower' to the ship-launched version and CSSC-2 'Silkworm'to the coastal defence version. Development of the HY-2 version started in 1970 as an improvement to the HY-1; the HY-2 is similar to the Russian SS-N-2C 'Styx' with the Russian designator P-21. The HY-2 has the NATO designator CSSC-3 'Seersucker', indicating a coastal defence version. It is this missile that has often been assumed to be the CSSC-2 'Silkworm' as they are similar in shape. Nevertheless, it is reported that HY-2 missiles are fitted to Chinese ships, although there is no separate NATO designator for these ship-launched versions. This missile has been fitted to 15 'Luda 1 and 2' class destroyers (Type 051), to 26 'Jianghu 1 and 2' class frigates (Type 053) and on one 'Chengdu' class frigate (Type 01). An alternative design was developed in China in parallel with the HY-2, called Fei Long-I (FL-1) and this missile is believed to have entered service in 1980. FL-1 was given the NATO designator CSS-N-1 'Scrubbrush Mod 2' (see separate entry). Over the years the Chinese have fitted several different terminal guidance seekers including an active I-band radar (HY-2 and -2G), infra-red (HY-2A) and an active monopulse radar (HY-2B), together with a radio altimeter for the HY-2B and -2G versions. During the late 1970s, development started on an air-launched version of the HY-2, given the designator C-601 by the Chinese when describing their export version. Export versions of ground- and ship-launched HY-2 missiles have been displayed at exhibitions up to 1996, with the designator c-201.

Description

The general configuration of the missile is similar to a small aircraft, with two delta wings and triform rudder and tail. HY-1 has a body length of 5.8 m, a body diameter of 0.76 m, a wing span of 2.4 m, a high-explosive warhead of 400 kg and a launch weight including the boost motor of 2,300 kg. Guidance for HY-1 is by autopilot

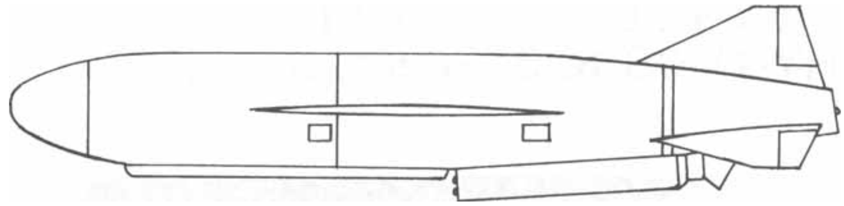


The nose of an HY-1 missile with the front access hatch of the launch canister maintenance



A Chinese HY-2 (CSSC-3 Seersucker7 missile on a wheeled launcher trailer

The launch of an HY-1 (CSS-N-2 'Safflower?missile



A line diagram of the HY-1 (CSS-N-2 'Safflower' and CSSC-2 'Silkworm')

in the mid-course, with an I-band active radar for the terminal phase. The active radar seeker has six selectable frequencies, set before launch. The terminal phase is activated by a timer at about 10 km from the target. The minimum range is 20 km and the maximum range for HY-1 is believed to be 85 km. HY-1 has a solid-propellant boost motor located under the rear body of the missile and this is jettisoned about 3 km from the launch site. The main sustainer motor is liquid propellant, using TG02 (triethylamine and xylidine) and kerosene pressurised by compressed air and fed via a turbopump to the combustion chamber. The missile has a cruise speed of M0.7. HY-1 missiles can be launched from ship-mounted canisters or from a simple four-wheeled trailer.

HY-2 is similar in shape but is 7.36 m long, has a body diameter of 0.76 m, a warhead of 513 kg and a launch weight of 3,000 kg. There are at least three terminal guidance systems used on the HY-2 missiles: an improved active I-band conical scan radar used on HY-2 and -2G; an infra-red seeker on HY-2A; and a monopulse active radar on HY-2B. HY-2 cruises at 100 to 300 m altitude, and the HY-2G version at 30, 50 or 100 m descending to 8 m for the terminal phase before diving down onto the ship target. The terminal phase can be preset on the ground to start at between 9 and 14 km from the target. The altitude is controlled by a radio altimeter (operating at 4 GHz), which was improved on the HY-2B and -2G versions. HY-2 has a maximum operational range of about 95 km, although the kinetic range is 105 km. The boost motor is similar to that on the HY-1 missile, but the HY-2 also has a liquid-propellant sustainer motor that uses UDMH and kerosene. It can operate at two thrust levels and the missile cruises at M0.9. In the shore-based coastal defence configuration, HY-2 missile targets are acquired by mobile truck-mounted radars. A typical fire unit has one radar vehicle, a display/control vehicle, a test vehicle, four launchers and four reload missiles. Many improvements have been made to the ship and ground launch facilities since HY-2 missiles first entered service, including digital computers.

Operational status

HY-1 (CSS-N-2 'Safflower' and CSSC-2 'Silkworm') entered service in 1974 and the later HY-2 (CSSC-3 'Seersucker') is believed to have entered service in 1978. A total of around 310 ship-mounted HY-2 launchers were believed to be in service with the Chinese Navy, with an additional 50 or so coastal defence installations, making a total of HY-1 and HY-2 missiles in service between 600 and 1,000 at the end of 1996. However, the Chinese are now replacing these missiles with YJ-1 and YJ-2 systems. A North Korean production line was set up for both HY-1 and HY-2 versions in the 1970s and it is believed that North Korea is making the HY-2 version. It was reported that 80 HY-2 missiles were sold to Iran, by China or North Korea in 1986, for use as ground-launched coastal defence missiles. Iran has assembled and manufactured HY-1 and HY-2 missiles since 1987 and missiles were probably also made in Egypt. A report in June 1989 suggested that the Chinese agreed to make designs available that would increase the range, although these countries could have used extensions to the fuel tanks as used by Iraq in the FAW family 'Styx' variants. It is reported that 'Silkworm' missiles were used by both Iran and Iraq in their war between 1980 and 1988, and again by Iraq in 1991. However, with the general confusion over HY-1 and HY-2 missiles and the 'Silkworm' designator, these may well have been CSSC-3 'Seersucker' missiles. It is reported that Iran targeted Kuwait oil installations with coastal defence HY-2 missiles in 1987, the first recorded use of 'Silkworm' missiles against land targets. Iran also used P3 Orion and C-130 Hercules aircraft to locate ship targets for the HY-2 missiles. Further exports of HY-1 and HY-2 missiles are believed to have been made to Albania, Bangladesh, Pakistan, Thailand and UAE. Iran is reported to have exported HY-1 'Silkworm' missiles to Sudan in 1991 and, in 1995, US intelligence reports indicated that Iran had around 100 HY-2 'Seersucker' missiles in service with 8 to 10 mobile coastal defence launch complexes, including a launcher on Sirri Island in the Persian Gulf.

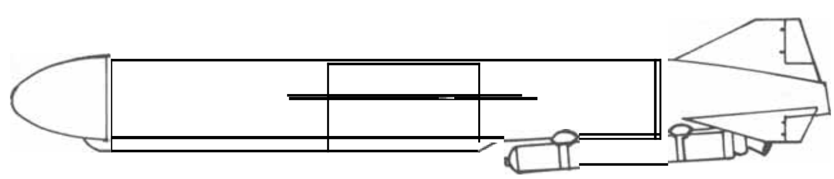
Specifications

CSS-N-2 **'Safflower'/CSSC-2** 'Silkworm' **(HY-1)**
Length: 5.8 m
Body diameter: 0.76 m
Launch weight: 2,300 kg
Payload: Single warhead; 400 kg
Warhead: Conventional HE
Guidance: Autopilot and active radar
Propulsion: Liquid propellant
Range: 85 km
Accuracy: n/k

CSSC-3 'Seersucker' **(HY-2/C-201)**
Length: 7.36 m
Body diameter: 0.76 m
Launch weight: 3,000 kg
Payload: Single warhead; 513 kg
Warhead: Conventional HE
Guidance: Autopilot with active radar or IR
Propulsion: Liquid propellant
Range: 95 km
Accuracy: n/k

Contractor

Chinese State Factories; but marketed by CPMIEC, Beijing.



A line diagram of the HY-2 (CSSC-3 Seersucker') missile

CSSC-5 'Saples' (YJ-16/C-101)

Type

Short-range, air-, ground- and ship-launched, ramjet-powered, single warhead missiles.

Development

In the late 1950s. the former USSR supplied China with a number of P-15 missiles, given the NATO designator SS-N-2A 'Styx'. The Chinese designated these Russian missiles SY-1 (NATO designator CSS-N-1 'Scrubbrush') and they formed the baseline design for a major part of the Chinese missile inventory from the 1960s to the 1980s. During the late 1960s. the Chinese built their own version of the 'Styx', called Hai Ying-1 (HY-1). HY-1 was built as a ship-launched and coastal defence anti-ship missile. Although these missiles were identical NATO gave separate designators, allocating CSS-N-2 'Safflower' to the ship-launched version and CSSC-2 'Silkworm' to the coastal defence version. Development of the HY-2 version started in 1970 as an improvement to the HY-1; the HY-2 is similar to the SS-N-2C 'Styx' with the Russian designator P-21. The HY-2 has the western designator CSSC-3 'Seersucker'. Development of the Ying Ji-16 (YJ-16) ramjet-powered missile probably started in the late 1970s. and was designed to give supersonic capability against ship targets. This missile has the NATO designation CSSC-5 'Saples' although the Chinese have advertised three versions of the missile with ground-, ship- and air-launched versions. The export missile has the Chinese designator C-101 and models of C-101 have been shown at exhibitions since 1986. The air-launched version (YJ-16) is believed to have been developed first, with the ground and then ship-launched versions following later. It is possible that YJ-16 was originally developed as a test-bed for ramjet motors, with the in-service role an opportunity only. The air-launched version was cleared for carriage by Harbin H-5 (11-28 'Beagle'), Xian H-6 (Tu-16 'Badger') and probably the SH-5 amphibian. YJ-16/C-101 appears to use the smaller FL-2/FL-7 (CSS-NX-5 'Sabbot') airframe and this may indicate that it was developed by the same design team. Reports in 1998 indicated that some YJ-16 missiles are still in service and are fitted to fast attack craft for coastal defence, probably with either two or four missile installations on 'Houjian' (type 037/2), 'Hegu' or 'Hoku' (type 024) class boats.

A model of the air-launched YJ-16 (C-101) missile, displayed in 1986 (via John W R Taylor)
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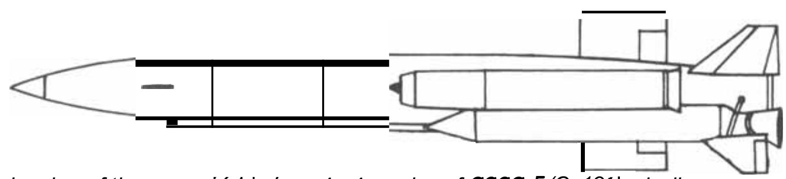
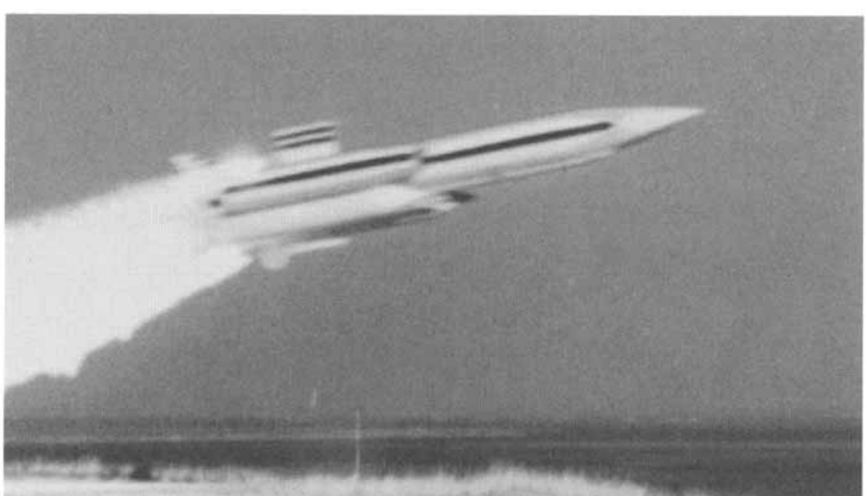


*A line drawing of the ground/ship-launched version of **CSSC-5** (C- 101) missile*

Description

YJ-16/C-101 has two side-mounted ramjet engines at the rear of the missile and the latest models show two square vertical fins, with rudders above and below the missile body. An electrical loom strake runs from the forward radar seeker assembly below the body to the rear control and power section of this missile. There are also two small moving delta canard fins at the nose of the missile. The air-launched version has a small tandem-mounted boost motor at the rear of the missile, whilst the ship- and ground-launched versions have two large strap-on booster motors mounted under the body just below the ramjet engines. YJ-16 is a more modern version of the basic HY-1 airframe, with a length of 6.5 m, a body diameter of 0.54 m and a launch weight for the ship-launched version, including booster motors, of 1,850 kg. The air-launched version is 7.5 m long, has a body diameter of 0.54 m, and a launch weight of 1,500 kg including the smaller tandem-mounted boost motor assembly. The missile has inertial mid-course guidance with a radar altimeter, but without command updates, and an active monopulse 10 to 12 GHz (X-band) radar terminal seeker. When the aircraft or ship's radar locates the target, the control system pre-programmes the missile flight trajectory together with co-ordinates for the start of the active radar terminal phase. The terminal radar starts an azimuth search for the target at between 20 to 10 km from the target. The ship-launched missile is housed in a deck-mounted canister; it has two solid-propellant boost motors attached to the underside that accelerate the missile to M1.8 before being jettisoned. The air-launched missile is dropped at launch. On achieving a clearance of 60 m a tandem-mounted solid-propellant boost motor ignites and accelerates the missile to M1.8. Both versions cruise at M2.0, powered by two ramjet engines using kerosene fuel. It is believed that the missile has a semi-armour-piercing warhead of 300 kg, fitted



A Chinese YJ-16/C-101(CSSC-5) surface-to-surface missile at launch

with a delayed impact fuze. From a cruise height of 50 m, the missile descends from a distance of 3 km before reaching the target to impact it 5 m above the waterline. This terminal manoeuvre is designed to make interception by ship-based defences more difficult. YJ-16/C-101 is reported to have a minimum range of 12 km and a maximum range of 45 km.

Operational status

YJ-16 probably entered service in China as an interim air-launched anti-ship missile in 1988, and as a ground- or ship-launched missile from 1989. The air-launched version is believed to have been taken out of service from 1992, following the introduction of the much lighter YJ-1 (C-801) missile, and by 1995 there were no missiles left in service. The Chinese advertised the YJ-16 (C-101 export version) from 1986 to 1997, but there are no known exports. The NATO designator, CSSC-5, indicates that the primary role of this missile system is for coastal defence, although some missiles are also fitted to FACs.

Specifications

Length: 6.5 m, (ship/ground); 7.5 m, (air)
Body diameter: 0.54 m
Launch weight: 1,850 kg, (ship/ground); 1,500 kg, (air)
Payload: Single warhead
Warhead: HE 300 kg SAP
Guidance: Inertial and active radar
Propulsion: Ramjet
Range: 45 km
Accuracy: n/k

Contractor

Not known, but marketed by CPMIEC, Beijing.

CSSC-6 'Sawhorse' (HY-3/C-301)

Type
Short-range, ground-launched, ramjet-powered, single warhead surface-to-surface missile.

Development
The Chinese have continued with the development of a series of coastal defence anti-ship missiles that started in the 1950s. The HY-1 (CSS-N-2 'Safflower' and CSSC-2 'Silkworm') and HY-2 (CSSC-3 'Seersucker') series have been further developed with the HY-4 which incorporates a turbojet engine, and the YJ-16/C-101 which utilises two ramjets for supersonic cruise speed. The Hai Ying-3 (HY-3) development programme started in the mid-1980s and is a variant of the twin ramjet-powered CSSC-5 'Saples' (YJ-16/C-101) with a longer range. HY-3 has been allocated the NATO designation CSSC-6 'Sawhorse'. The HY-3 has been designed for ground launching as a coastal defence weapon and is almost certainly too heavy for air carriage. It has been Chinese practice to give their export missiles a separate designator, and they may not be identical to the version used by the Chinese armed forces; in this case the HY-3 export version is known as the C-301. There are reports that HY-3 will also be developed with an extended range, for ship launch, and as a cruise missile for attacking land targets. In 1996, CPMIEC stated that an improved HY-3A version with a range of 180 km was in development, with guidance system upgrades being developed by the Hai Ying Electro-Mechanical Technology Academy.

HY-3 (NATO designation CSSC-6 'Sawhorse? coastal defence SSM on its launcher. showing the cluster of four solid propellant boost motors wrapped around the two ramjet engines

Description
HY-3 has two side-mounted ramjet engines at the rear, two small moving delta canards at the nose and two clipped delta fins above and below the missile body at the rear. At launch there are four solid-propellant boost motors wrapped around the rear body, each with an additional fin assembly, but the motors are jettisoned after the boost phase. The missile body is 9.46 m long, but with the boost motors the overall length is 9.85 m. The body diameter is 0.76 m, the fin span is 2.24 m and the launch weight, including the four boost motors, is 4,900 kg. The HY-3 has inertial mid-course guidance with a radio altimeter controlling the cruise altitude at between 50 and 300 m. An alternative cruise altitude *is* at 6,000 m (20,000 ft). Terminal guidance is provided by an active monopulse radar seeker and is probably similar to the 10 to 20 GHz (X-band) seeker in the YJ-16/C-101 missile. The missile has a programmed dive phase from the cruise altitude down to about 30 m before the active radar terminal phase begins, and then dives down on to the target just before impact. Before launch, the coordinates of the ship target are programmed into the missile, together with the flight trajectory selected. Four solid-propellant wraparound booster motors accelerate the missile to about M I.8 and up to an altitude of 300 m, and are then jettisoned; the kerosene fuel ramjet engines take over and accelerate the missile to M2.0, with this cruise speed maintained until target impact. The missile penetrates the hull of the target ship by kinetic energy, and the 513 kg fragmentation warhead is initiated by a delayed contact fuze. In addition to the contact fuze there is a separate active laser proximity fuze, in case the missile flies close to the target ship but without an impact. HY-3 has a minimum range of 35 km and a maximum range of 140 km. The improved HY-3A version has a maximum range increased to 180 km, a reduced weight of 4,600 kg at launch, and cruises at low level at 100 or 300 m. The basic fire unit for the HY-3 system includes: four missiles on their launchers; four missile transport vehicles; a radar and command vehicle; and three power supply vehicles. These vehicles are similar to those used with the YJ-1/YJ-2 systems (see separate entry).

A rear view of the HY-3 missile on its launcher (CPMIEC) 0003131

Operational status

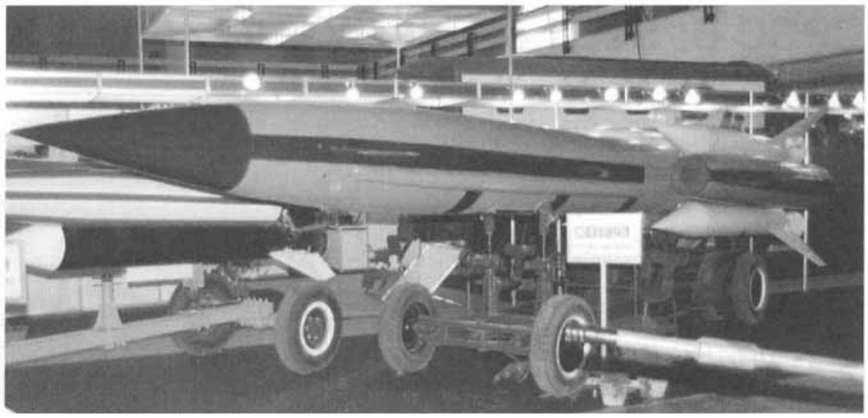
It is believed that the HY-3 (CSSC-6 'Sawhorse') missile has completed development and that it entered service in 1995, but this has not been confirmed. An improved HY-3A version has been offered for export from 1999, with an increased range. There have been no known exports, but C-301 was still being offered for export in 2001. It is believed that there are between 50 and 150 missiles in service in China, all used for coastal defence.

Specifications

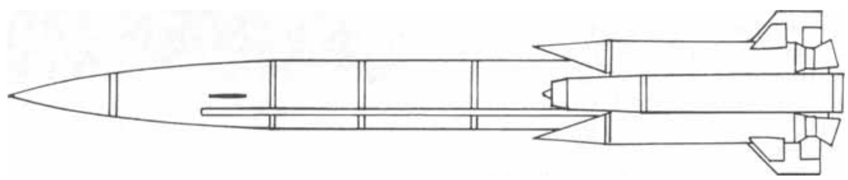
Length: 9.85 m
Body diameter: 0.76 m
Launch weight: 4,900 kg (HY-3) or 4,600 kg (HY-3A)
Payload: Single warhead
Warhead: HE fragmentation 513 kg
Guidance: Inertial and active radar
Propulsion: Ramjet
Range: 140 km (HY-3) or 180 km (HY-3A)
Accuracy: n/k

Contractor

Not known, but marketed by CPMIEC, Beijing.



An HY-3 surface-to-surface missile displayed at an exhibition in Beijing in 1988 0062809



A line drawing of the HY-3/C-301 (CSSC-6 'Sawhorse7 missile

CSSC-7 'Sadsack' (HY-4/C-201)


The command vehicle (left) and surveillance radar vehicle (right) for the coastal defence CSSC-7 (HY-4) missile system (CPMIEC) 0003134

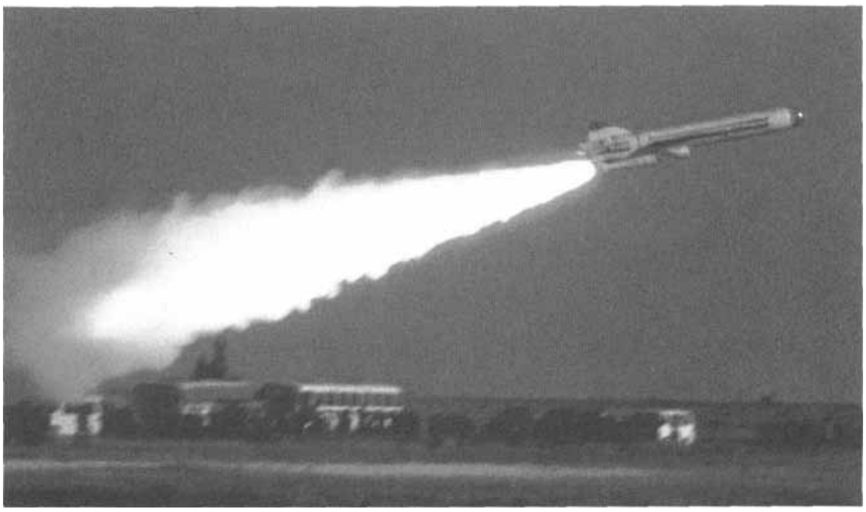
A CSSC-7 (HY-4) ground-launched missile on its mobile launch vehicle (CPMIEC) 0003133

Type

Short-range, ground-, air- and ship-launched, turbojet-powered, single warhead missile.

Development

In the late 1950s. the former USSR supplied China with a number of P-15 missiles, given the NATO designator SS-N-2A 'Styx'. The Chinese designated these Russian missiles SY-1 (NATO designation CSS-N-1 'Scrubbrush'), and these missiles formed the baseline design for a major part of the Chinese missile inventory from the 1960s to the 1980s. During the late 1960s. the Chinese built their own version of the 'Styx'. which were called Hai Ying-1 (HY-1). HY-1 was built as a ship-launched and coastal defence anti-ship missile, and was given the NATO designator CSSC-2 'Silkworm' for the coastal defence version and CSS-N-2 'Safflower' for the ship-launched version. Development of the HY-2 version started in 1970 as an improvement to the HY-1; the HY-2 is similar to the former Soviet SS-N-2C 'Styx' with the designator P-21. The HY-2 has the Western designation CSSC-3 'Seersucker'. Development of the Hai Ying-4 (Sea Eagle-4/HY-4) is believed to have started in the mid-1970s. using the monopulse active radar seeker developed for the HY-2G and replacing the liquid propellant sustainer motor with a small turbojet engine. The engine technology is believed to have been taken from US BQM-34 Firebee drones recovered by the Chinese, and the Chinese CH-1 drone, a copy of the Firebee design, first flew in 1972 fitted with a WP-11 turbojet. Reports suggest that an improved version of the HY-4, known as HY-41 or XW-41, was developed from about 1987, but it is believed to have been terminated around 1991. The Chinese have also shown models of a missile with the designator C-201 and C-201W, which is believed to be an export version of HY-4. The Chinese have stated that the C-201W (probably the export version of the HY-41 upgrade) has a range increased to 200 km. HY-4 has also been developed as an air-launched missile and this entered service in 1990. The air-launched version is believed to have been carried on the Xian H-6 (Russian Tu-16 'Badger') aircraft, with two missiles carried, one under each outer wing pylon. Only about 30 H-6 aircraft were modified to carry the HY-4 missiles and were then designated B-6D. It is believed that the export designator C-611 may apply to the air-launched version of HY-4. HY-4 has been given the NATO designator CSSC-7 'Sadsack'. indicating that the missile's primary role was coastal defence, and there is no confirmed use of this missile from ships.


A ground-launched CSSC-7 (HY-4) cruise missile (CPMIEC) 0003132

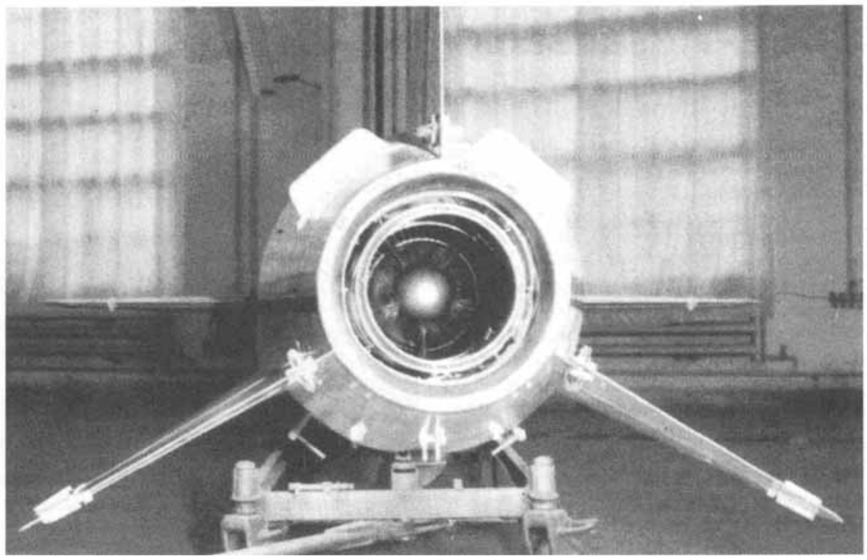
Description

The general configuration of the anti-ship HY-4 missile is similar to HY-1 and HY-2, with two delta-wings and triform rudder and tail. HY-4 has a large ventral scoop air inlet for the turbojet engine under the centrebody of the missile. It has a length of 7.36 m, a body diameter of 0.76 m, a wingspan of 2.4 m, a high explosive shaped charge warhead of 513 kg and a launch weight including the solid propellant boost motor of 1,950 kg. The air-launched version has no solid propellant boost motor and weighs 1,740 kg at launch. Guidance for HY-4 is by autopilot in the mid-course, with a 10 to 20 GHz (J-band) monopulse active radar for the terminal phase. The missile has a radio altimeter, which allows the cruise height to be varied between 70 and 200 m altitude, followed by a steep dive on to the target. HY-4 carries 200 kg of kerosene fuel, has a minimum range of 35 km and a maximum range of 135 km. The later HY-41 (export model C-201W) has a maximum range of 200 km, achieved by carrying more fuel in the missile. HY-4 has a cruise speed of

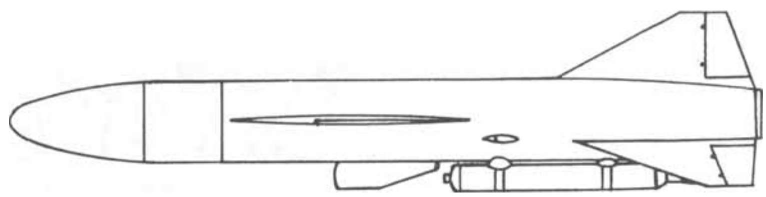
M0.8. The solid-propellant boost motor located under the rear body of the missile is jettisoned after launch. A typical firing battery has four mobile launch vehicles, a surveillance radar vehicle, a command vehicle and a power generation vehicle. The H-6 aircraft (Tu-I6 'Badger') was modified to the B-6D standard to carry HY-4 missiles.

Operational status

HY-4 entered service around 1985 in the ship-launched and coastal defence versions, with the air-launched version entering service in 1991. It is believed that only 30 Xian H-6 bombers were modified to carry HY-4 missiles, that 100 missiles are available in reserve for use in the ASM role, and a further 250 missiles available for coastal defence. An unconfirmed report suggests that HY-4 coastal defence missiles may have been exported to Iran. A later version, HY-41 (or XW-41), is believed to have been developed but terminated in 1991 following the successful development of the YJ-1 and YJ-2 missiles. Further versions of HY-4 were offered for export in the early 1990s. designated C-201 or C-201W for the ground-launched missile and C-611 for the air-launched, but there have been no reported exports.



A rear view of the HY-4 missile, showing the turbojet engine exhaust nozzle and the trifortn tail



*A line drawing **of** the ground-launched HY-4 (CSSC-7 'Sadsack') missile*

Specifications

Length: 7.36 m
Body diameter: 0.76 m
Launch weight: 1,950 kg (ground), 1,740 kg (air)
Payload: Single warhead; 513 kg
Warhead: Conventional HE
Guidance: Autopilot and active radar
Propulsion: Turbojet
Range: 135 km (HY-4), 200 km (HY-41)
Accuracy: n/k

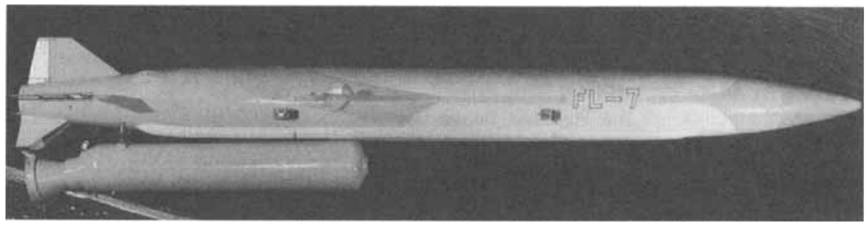
Contractor

Chinese State Factories; but marketed by CPMIEC, Beijing.

CSS-N-I 'Scrubbrush Mod 2' (FL-I), CSS-NX-5 'Sabbot' (FL-2), FL-7 and FL-10

Type

Short-range, ship-launched, liquid- or solid-propellant, single warhead surface-to-surface missiles.



The FL-7 missile. showing the size and location of the solid-propellant boost motor

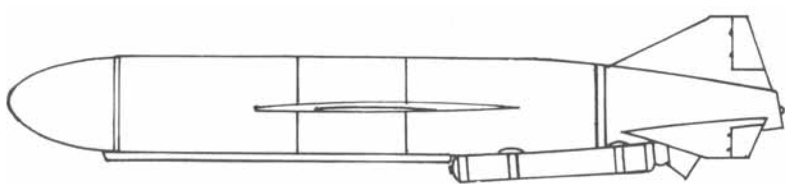
Development

In the late 1950s the former USSR supplied China with a number of P-15 missiles, given the NATO designator SS-N-2A 'Styx'. The Chinese designated these Russian missiles SY-1 (NATO designator CSS-N-1 'Scrubbrush'), and it is believed that Fei Long-I (FL-1) is a later Chinese built version with an improved active radar terminal seeker, given the NATO designator CSS-N-1 'Scrubbrush Mod 2'. These 'Styx' missiles formed the baseline design for a major part of the Chinese missile inventory from the 1960s to the 1980s. During the late 1960s. the Chinese built their own version of the 'Styx'; these were called Hai Ying-1 (HY-1). HY-1 was built as a ship-launched and coastal defence anti-ship missile. Although these missiles were identical, NATO gave separate designations, allocating CSS-N-2 'Safflower' to the ship-launched version and CSSC-2 'Silkworm' to the coastal defence version. Development of the HY-2 version started in 1970 as an improvement to the HY-1, and the HY-2 is similar to the former Soviet SS-N-2C 'Styx' with the Russian designator P-21. The HY-2 has the western designator CSSC-3 'Seersucker'. This similarity between the Chinese missiles has caused considerable confusion amongst western observers, particularly with the Fei Long missiles which, it is believed, were separately designed to compete with the Hai Ying family. FL-1 was first shown outside China in 1984 and the FL-2 was seen at the Farnborough Air Show in 1986. FL-2 is a solid-propellant version of FL-1 but in a smaller airframe, and has the NATO designator CSS-NX-5 'Sabbot'. The third known member of the FL family, the FL-7, was announced in 1988; this uses the smaller airframe of the FL-2 but returns to a liquid-propellant motor.The latest member of the family, the FL-IO, was only reported in 1998 when a US report stated that Iran had started licensed production of this version. The FL-10 is reported to be used from helicopters and fast attack craft in Iran. It is believed that FL-1 missiles were fitted to some 'Huangfen' class fast attack missile vessels.

Description

The general configuration of the FL-1 missile is similar to HY-1 and HY-2 in shape, with two delta wings and triform rudder and tail. FL-1 has a length of 6.42 m, a body diameter of 0.76 m and a warhead of 513 kg that is believed taken from the 'Styx' and HY-2 missile designs. FL-1 has a missile weight of 1,740 kg and a launch weight including the solid-propellant boost motor of 2,000 kg. These parameters make FL-1 very similar in size and weight to the HY-4 missile, but without the turbojet engine of the HY-4. Guidance for FL-1 is by autopilot in the mid-course, with a J-band monopulse active radar for the terminal phase. The missile has a radio altimeter which gives the missile a sea-skimming capability at 30 m in mid-course and down to 8 m in the terminal phase. FL-1 has a jettisonable solid-propellant boost motor mounted under the rear body and a liquid-propellant sustainer motor giving the missile a range of about 45 km at subsonic speed.

FL-2 is a smaller missile than FL-1, with a length of 6.0 m and a body diameter of 0.54 m. The major external difference is that the FL-2 missile has a small horizontal stabiliser mounted beneath the rudder on top of the rear body, otherwise the outline shapes are similar. FL-2 has a smaller 365 kg warhead, a missile weight of 1,300 kg and a launch weight including a solid-propellant boost motor of 1,550 kg. FL-2 appears to use the same guidance and flight profiles as FL-1, although the liquid-propellant sustainer motor of FL-1 has been replaced with a solid-propellant motor in FL-2. The new motor gives the

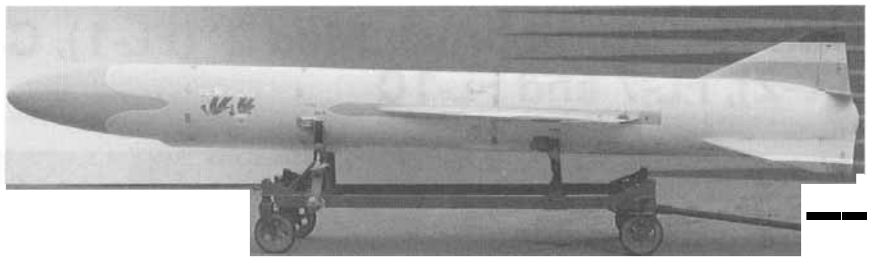

*A line drawing of the FL-**1** **(CSS-N-1** 'ScrubbrushMod 2') missile*


An FL-1 (CSS-N-1 Scrubbrush') surface-to-surface missile being launched from a fast patrol boat of the Chinese Navy

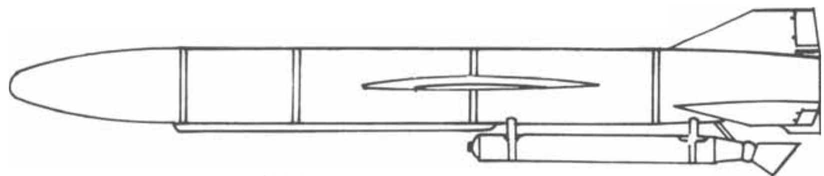
FL-2 a range of 50 km and a cruise speed of MO 9 There are reported to be several types of warhead available for FL-2, including a hollow charge design.

FL-7 is a supersonic version of FL-2, with a claimed maximum speed of M1.4. This version of the FL familv has a lenath of 6 6 m, a body diameter' of 0 54 m and a launch weight including the jettisonable solid boost motor of 1,800 kg The small horizontal stabiliser of the FL-2 has been removed and the sustainer motor changed back to liquid propellant. The range of FL-7 is reported to be 30 km. It is assumed that FL-7 uses the same guidance as FL-1 and has the smaller 365 kg warhead of FL-2. Little is known about FL-IO, which may be a license-built version of FL-1, FL-2 or FL-7, or may even be a new version of this family.

It is believed that the FL family of missiles have all been designed to use the HY-1, HY-2 and HY-4 missile containers and fire-control systems.



The FL-2 missile (CSS-NX-5 Sabbot], showing the distinctive short strake under the forebody and the small horizontal stabiliser under the rudder. This missile does not have the solid-propellant boost motor fitted



A line drawing of the FL-2 (CSS-NX-5 'Sabbot') missile

Operational status

The operational status of the Fei Long family of weapons is not clear, but it is believed that the FL-1 entered service with the Chinese Navy around 1980 as a competing system to the HY-1 and HY-2. FL-2 may have entered service around 1983, but it was possibly unsuccessful due to the unreliability of the solid-propellant sustainer motor and may therefore have been cancelled during development. FL-7 was developed in the mid-l980s. but it is believed that the programme was terminated in 1989 due to the limited range. There are no FL-1 missiles in service in China today. It is believed that some FL-1 missiles have been exported to Bangladesh, Egypt, Pakistan and Thailand. The FL-10 missiles being built under license in Iran are believed to be a joint development programme between China and Iran, and probably entered service in Iran in 2000.

Specifications

	FL-1	FL-2	FL-7
Length	6.42 m	6.0 m	6.6 m
Body diameter	0.76 m	0.54 m	0.54 m
Launch weight	2,000 kg	1,550 kg	1,800 kg
Payload	Single warhead 513 kg	Single warhead 365 kg	Single warhead 365 kg
Warhead	HE	HE	HE
Guidance	Autopilot and active Radar	Autopilot and active Radar	Autopilot and active radar
Propulsion	Liquid propellant	Solid propellant	Liquid propellant
Range	45 km	50 km	30 km
Accuracy	n/k	n/k	n/k

Contractor

Nanchang Aircraft Manufacturing Corporation, Jiangxi; but marketed by CATIC, Beijing.

CSS-N-3 (JL-1/-21)

Type

Intermediate-range, submarine-launched, solid-propellant, single warhead ballistic missile.

Development

The CSS-N-3 has the Chinese designation Ju Lang-1 (JL-1 or Giant Wave-I). The PRC started development of their first submarine-launched ballistic missile in 1967, for use with the 'Xia' class (type 092) of nuclear-powered submarine (SSN). The CSS-N-3 is thought to use some CSS-2 technology, but took a long time to develop due to the need to master the technologies associated with solid propellants, and because the smaller nuclear warhead and submarine programmes were both delayed. The first test firing of the 1.4 m diameter solid-propellant motor was made in 1978. Test firings were carried out in 1982, reportedly from a submerged pontoon (30 April) near Huludao and later, on 12 October, from a 'Golf' class trials submarine. There was a test firing of a similar missile from a mobile ground-launcher vehicle in 1985, indicating that the JL-1 design had been modified into a ground-mobile system known as DF-21 (NATO designator CSS-5).

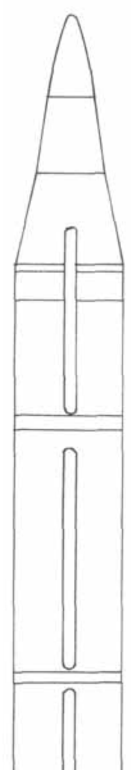
Development of an improved DF-21A version was completed in 1995, and it is believed that a similar improvement programme may have been made for a JL-1A. This later version has also been referred to as JL-21A. The single 'Xia' class submarine received an extensive refit from 1995 to 2000, which might indicate that an improved SLBM has been fitted. This boat participated in its first exercise, following the refit, in December 2000.

Description

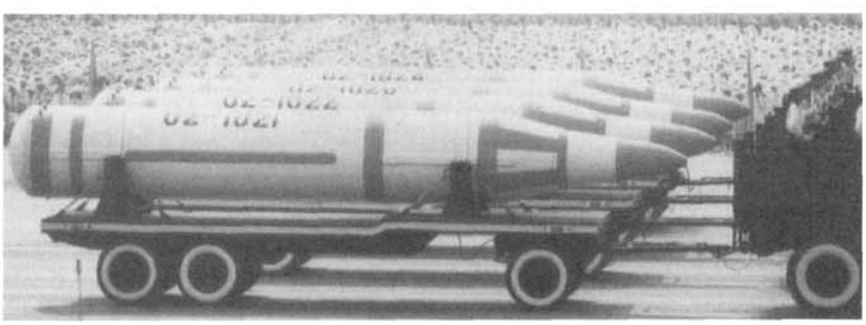
The CSS-N-3 is a two-stage, submarine-launched, solid-propellant ballistic missile. It has a length of 10.7 m, a diameter of 1.4 m and a launch weight of 14,700 kg. It is believed that the missile has a minimum range of 600 km and a maximum range of 2.150 km. The missile has a single nuclear warhead, thought to have a yield of 250 kT. The warhead separates from the second stage after motor burnout, and the payload assembly weighs 600 kg. A high-explosive warhead has been developed for the ground-based DF-21 version, and probably submunition, EMP and chemical warheads. There is no reason why these alternative warheads could not be fitted to the JL-1 missile as well. The guidance is inertial with an onboard computer and the accuracy is believed to be 700 m CEP. The single 'Xia' class submarine in service carries 12 JL-1 missiles, and these are cold launched from their canisters with the first-stage solid-propellant motor igniting after the missile has emerged from the water.

If the JL-1A (or JL-21A) missile is similar to the ground-launched DF-21A, then it will probably have a reshaped nose section with a straight ogive. The missile has a length of 12.3 m, a body diameter of 1.4 m and a launch weight of 15,200 kg. The payload is believed to be 500 kg with a single nuclear warhead, with either a 90 kT yield, or selectable between 20, 90 and 150 kT. The guidance has GPS updates and a terminal radar correlation system, providing an improved accuracy believed to be around 50 m CEP, although other reports suggest CEPs of between 15 and 150 m. The two-stage solid propellant motors give this version a minimum range of 500 km and a maximum range of 2,500 km.

A trials launch of a JL-1 SLBM made from a Xia class boat in 1990 (Xinhua News Agency)
0022181



A line drawing of the CSS-N-3 (JL-1) missile



The CSS-N-3 submarine-launclied missile

Operational status

CSS-N-3 (JL-1) missiles were ceremonially paraded in Beijing in October 1984 and it is believed that they became operational in 1987 on the first operational 'Xia' class submarine. Three trial launches were made in 1985; the first operational test launch from a 'Xia' class boat was made in 1988, and a second in 1990. A multiple launch, possibly of three missiles, was reported in August 2001. It is estimated that 15 to 20 missiles remain in service, with the spare missiles stored at the Huludeo submarine base. Although two 'Xia' class boats are thought to have been built, only one remains in service. The ground-launched version, CSS-5 (DF-21). entered service in 1987. An improved ground-launched missile, DF-21A, entered service in 1996 and it is possible that an improved JL-1A (or JL-21A) has been fitted to the upgraded 'Xia' boat during its recent refit, although some reports suggest that the three-stage JL-2 missiles (similar to the DF-31) might be fitted.

Specifications

JL-1
Length: 10.7 m
Body diameter: 1.4 m
Launch weight: 14,700 kg
Payload: Single warhead; 600 kg
Warhead: 250 kT nuclear
Guidance: Inertial
Propulsion: 2-stage solid
Range: 2.150 km
Accuracy: 700 m CEP

JL-1A/-21A
Length: 12.3 m
Body diameter: 1.4 m
Launch weight: 15,200 kg
Payload: Single warhead; 500 kg
Warhead: 90 kT or selectable 20, 90 or 150 kT nuclear
Guidance: Inertial with GPS and radar correlation
Propulsion: 2-stage solid
Range: 2,500 km
Accuracy: 50 m CEP

Contractor

It is believed to have been designed by the China Aerospace Industry Corporation, Beijing, which used to be the First Academy of the Ministry of Aerospace Industries. The final testing was carried out by the Wanyuan Industry corporation, Beijing, and the propulsion was designed by the 401st Institute for SLBM Motors.

CSS-N-4 'Sardine' (YJ-1/C-801) and CSSC-8 'Saccade' (YJ-2/C-802)

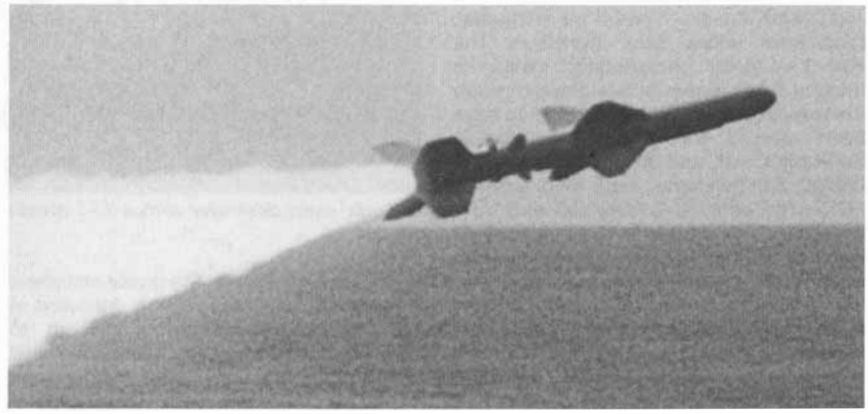
Type

Short-range, ground-, air-, submarine- and ship-launched, solid propellant or turbojet-powered, single warhead, air-to-surface and surface-to-surface missiles.

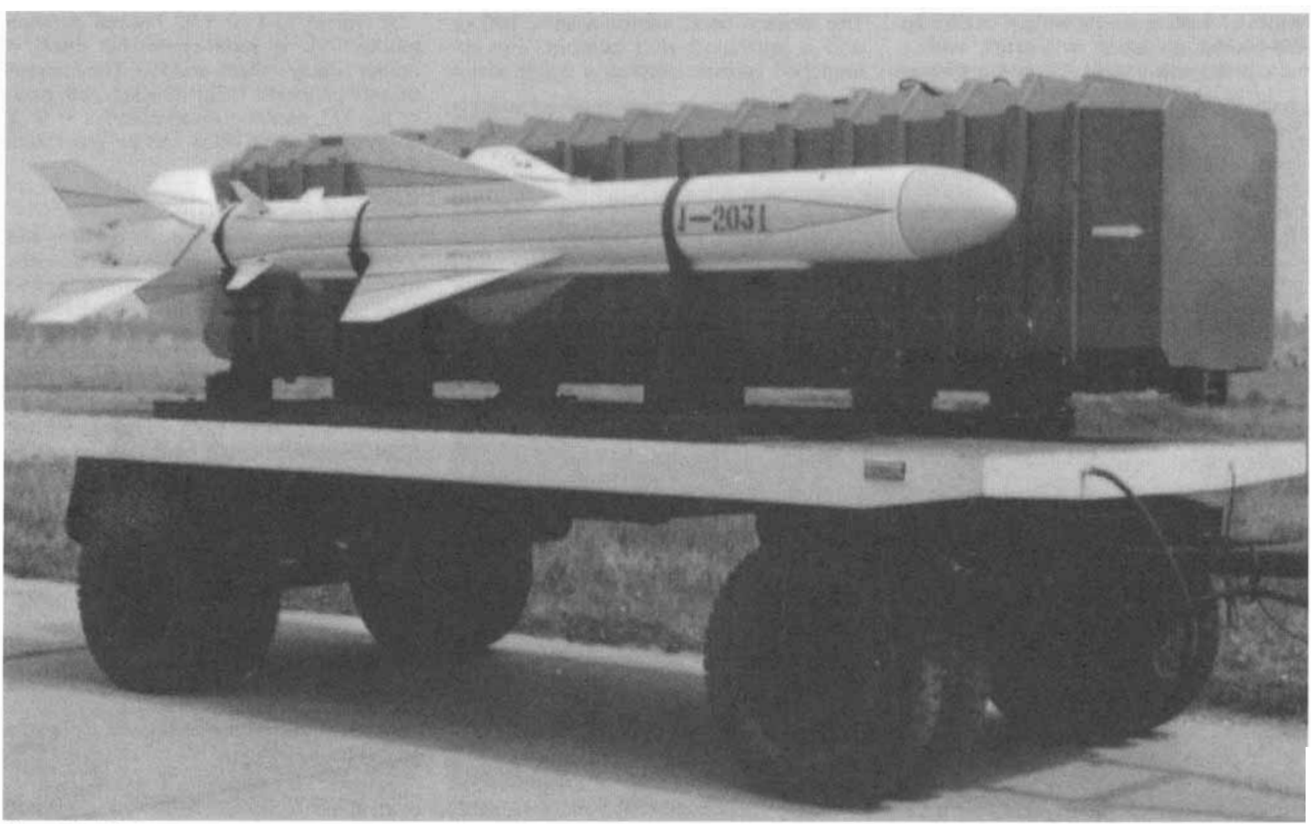
Development

Ying Ji-1 (or Eagle Strike-I) (YJ-1) was first revealed by the Chinese in 1984, probably having started development in the mid-1970s. The design was initially intended to be for a ship-launched and coastal defence weapon against ships, but YJ-1 can be launched from submarines and an air-launched variant has also been developed. It is believed that the Chinese designator C-801A refers to the export version of the ground- or ship-launched version, and C-801K to the air-launched version of YJ-1. NATO has given the designator CSS-N-4 'Sardine' to the YJ-1 missile system, although this missile has ground-launched coastal defence and air-launched versions. YJ-1 missile launchers are fitted to a modified 'Romeo' (Type 033G) class submarine with six external launchers, 'Song' class (Type 039). 'Kilo' class (Type 877EKM/636) and 'Han' class (Type 091) submarines, 'Luda' (Type 3) and 'Luhu' (Type 052) class destroyers, 'Jianghu 3 and 4' (Type 053 HT) and 'Jianwei 1 and 2 (Type 053 H2G and 053) frigates, 'Huang' (Houjian), 'Houxin', 'Huangfen', 'Hegu', 'Hema' and 'Hainan' fast attack craft with two or four canister launchers. It is reported that an encapsulated version of YJ-1, or an improved version designated YJ-8-2 or YJ-82, can be launched from submarines through their 533 mm torpedo tubes. It is believed that the modified 'Romeo' class submarine can also fire the encapsulated version through her torpedo tubes. The air-launched version has been reported to be carried on Nanchang Q-5 and JH-7 aircraft and the CHAIC Z-8 helicopter with two missiles carried on each. For ground launch the YJ-1 is carried by a 6 × 6 wheeled Transporter-Erector-Launcher (TEL) vehicle, with two launch canisters. It is believed that the YJ-1 is being built under licence in Iran, where it has the name 'Karus'. A modified version, designated YJ-12, is believed to be in development in China, with a range increased to 70 km, improved ECCM, and improved accuracy.

A second variant, YJ-2, completed development in 1993 (C-802A for the ground- or ship-launched export version and C-802K for the air-launched version) with the solid-propellant sustainer motor being replaced by a turbojet engine to give longer range. It is thought that this version has the NATO designator CSSC-8 'Saccade', which is a coastal defence designator, although the missile is used from ships and aircraft. YJ-2 started development in 1985 and was first tested in 1990. Small turbojet technology in China was initially developed from



A YJ-2 (C-802) surface-to-surface missile at launch (CPMIEC) 0022180



Ying Ji-1 (C-801 export version) surface-to-surface missile mounted beside its container, showing the jettisonable tandem boost motor assembly at the left-hand (rear) end

recovered BQM-34 Firebee drones, but later supplemented by auxiliary power units imported for use on civil aircraft programmes. YJ-2 missiles are fitted to 'Song' and 'Han' class submarinies, 'Luhai' and 'Luhu' class destroyers, 'Jiangwei 1 and 2' and 'Jianghu 3 and 4' class frigates, fired from above deck launchers. The YJ-8-3 or YJ-83 encapsulated version is fitted in submarines, for launching through the torpedo tubes. YJ-2 is believed to have been cleared for carriage on Su-27, Su-30MKK, Q-5 and JH-7 aircraft and the CHAIC Z-8 helicopter with two missiles carried by each. It is believed that YJ-2 missiles will be retrofitted to Chinese ships in place of YJ-1 missiles. 'Huangfen' fast attack craft, known as 'Hudong', have been exported to Iran for use with both YJ-1 and YJ-2 missiles, and it is reported that YJ-2 missiles are being built in Iran with the name 'Tondar'. Reports in 1994 indicated that an increased range YJ-2 version was also in development, designated YJ-21. A second development, YJ-22, was reported in 1997, adding wings to the YJ-2 1 design to increase the range to 400 km.

A 'Luda' class destroyer with a YJ-1 quadruple launcher assembly just aft of the forward funnel 0022179

Description

YJ-1 is similar in appearance to the French MM 38 Exocet, but the Chinese missile is heavier. YJ-1 has four clipped delta-wings at mid-body and four small clipped-tip triangular moving control fins at the rear. The overall length including the tandem-mounted booster motor is 5.81 m for the ground- and ship-launched versions, the body diameter is 0.36 m, the wing span is 1.18 m and the launch weight 815 kg. The tandem-mounted solid-propellant boost motor weighs 160 kg and is jettisoned after use. The air-launched version does not have a tandem boost motor, having a length of 4.65 m, and a weight of 655 kg. Mid-course guidance is inertial, with a monopulse active radar (probably X-band) in the terminal phase. The cruise altitude is believed to be around 20 m, followed in the terminal phase by a descent to between 5 and 7 m, both being controlled by a radio altimeter. YJ-1 has a high explosive warhead with a weight of 165 kg. The missile flies at around M0.85. YJ-1 is reported to have a minimum range of 8 km and a maximum range of 40 km when ground- or ship-launched, and a maximum range of 50km when air-launched from medium altitude (30,000 ft).

YJ-2 has an air inlet scoop beneath the missile body between the central wings to serve the turbojet engine that has replaced the solid-propellant sustainer motor of the earlier YJ-1 version. The missile has a cruise speed of M0.85, the mid-course cruise can be set at either 30 or 20 m and the terminal altitude at either 7 or 5 m. Guidance in mid-course is inertial with a monopulse active radar operating at 10 to 12 GHz (X-band). YJ-2 is longer at 6.39 m for the ground- and ship-launched version, but has a reduced launch weight of 715 kg. The tandem boost motor weighs 160 kg and is jettisoned after burnout. The air-launched version, without a boost motor assembly, has a length of 5.3 m and a launch weight of 555 kg. It is reported that YJ-2 has a maximum range of 120 km when ship or ground launched and 130 km when air-launched from medium altitude (30,000 ft), and a minimum range of 15 km. The warhead remains the same as for YJ-1.

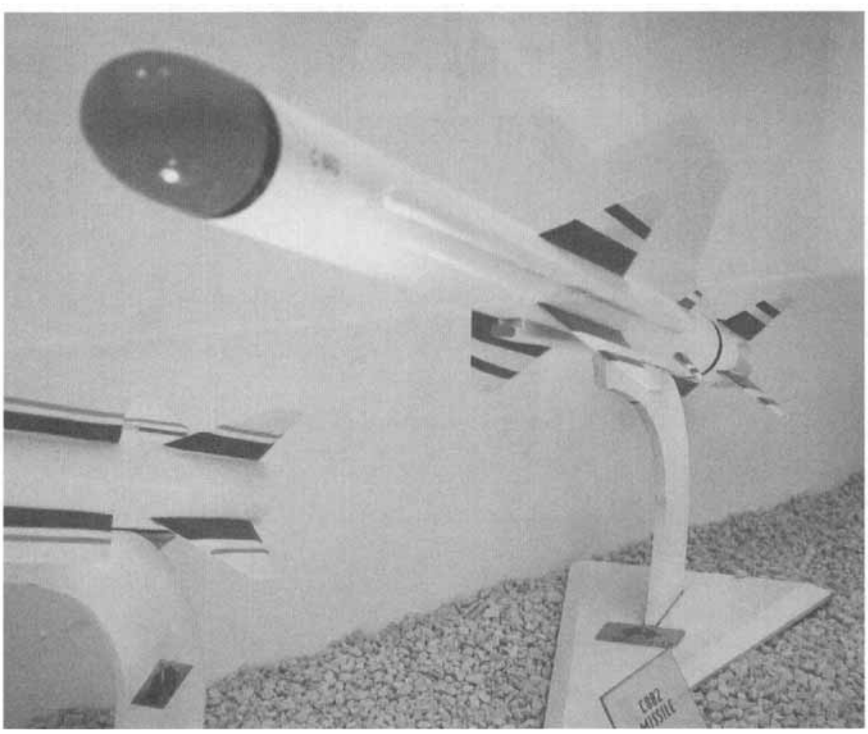
YJ-2 1 has a maximum range of 180 km and is expected to have a land attack capability with an INS/GPS guidance system. The missile has redesigned electronic components and can carry more fuel than the YJ-2 version.

YJ-83 (or YJ-8-3) has a turbojet engine. but can cruise at M1.3 at high level This missile is similar to YJ-2, and is seen as an interim solution until the faster Russian SS-N-22 'Sunburn' anti-ship missile is capable of being built in China. YJ-83 can be launched from submarine torpedo tubes, and is fitted inside a launch capsule, which is ejected after broaching the water. The missile can also be carried by aircraft, and launched from ships or coastal defence TEL.

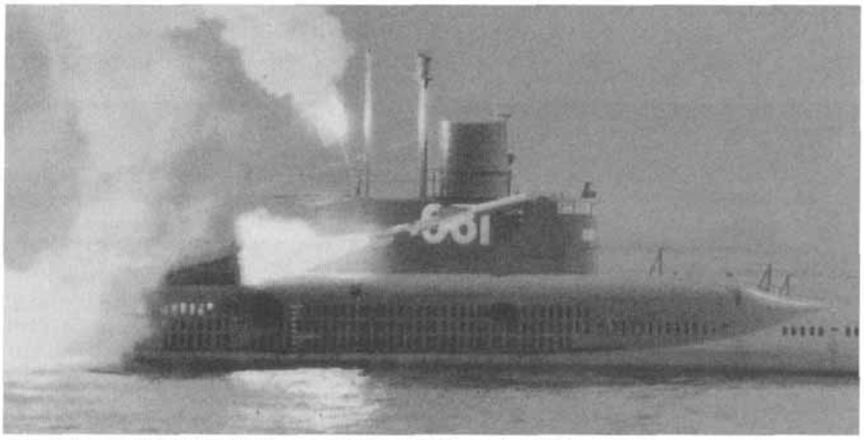
A typical YJ-1 or YJ-2 coastal defence battery has a radar-command truck, a power supply vehicle and four Transporter-Erector-Launcher (TEL) vehicles, with each of the TEL carrying three missiles in their canisters. The vehicles can be used with YJ-1 or YJ-2 missiles.

Operational status

YJ-1 is in production and the ground- and ship-launched versions entered service around 1984 with the Chinese armed forces. The air-launched version is believed to have entered service in 1989. A reported purchase of YJ-1 (C-801 export version) by Thailand in 1990, for 50 missiles to arm their 'Jianghu 4' class frigates, was the first known export of YJ-1. Further exports could have been made to


A model of a YJ-2 missile displayed in 1998, showing the distinctive air inlet shape under the body between the wings (Duncan Lennox) 0062810

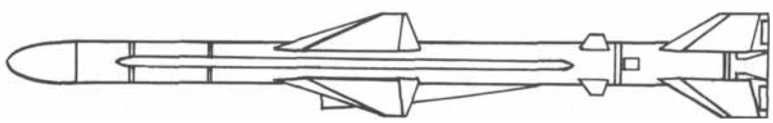

A radar command vehicle. used with the YJ-1 and YJ-2 coastal defence systems



A launch of a YJ-1 missile from a modified Chinese-built 'Romeo' class submarine

The power supply vehicle associated with the YJ-1 and YJ-2 coastal defence launch batteries

A YJ-1 and YJ-2 Transporter-Erector-Launcher (TEL) vehicle with three missiles in canisters



Line drawings of the YJ-1 (top) and YJ-2 (bottom) ground- or ship-launched missiles

Iran, North Korea and Yemen for use as coastal defence weapons from fixed sites or mobile launchers. Iran has fitted YJ-1 missiles to F-4 Phantom aircraft and trials launches were made in 1997. An unconfirmed report suggests Iran is building YJ-1 (C-801A and C-801K) missiles under the project name 'Karus'. About 500 missiles are thought to be in service in China. A modified version, known in China as YJ-12, was reported to be in development in 1996.

YJ-2 was first tested in 1990, and could have entered service with the Chinese Navy in 1994. YJ-21 may have entered service in 1998, and there were two test launches made in May and July 2001. Reports in 1995 stated that 100 YJ-2 missiles had been ordered by Iran, with test launches from ground sites reported in early 1996 and fitment to 'Hudong' fast attack craft. Up to 10 'Hudong' PCFG (Patrol Craft Fast-Guided) have been delivered to Iran, each capable of carrying four YJ-2 missiles. Later unconfirmed reports suggest that Iran may be manufacturing YJ-2 missiles under licence, with the project name 'Tondar'. Pakistan has ordered YJ-2 missiles to fit to their Jalalat 2 FACs, with four missiles per boat. The first YJ-83 version (or YJ-8-3) is believed to have entered service in 1998, and was displayed in Beijing in October 1999.

Specifications

YJ-1 (C-801)
Length: 5.81 m (ground/ship), 4.65 m (air)
Body diameter: 0.36 m
Launch weight: 815 kg (ground/ship), 655 kg (air)
Payload: Single warhead; 165 kg
Warhead: Conventional HE
Guidance: Inertial and active radar
Propulsion: Solid propellant
Range: 40 km (ground/ship), 50 km (air), 70 km (YJ-12)
Accuracy: n/k

YJ-2 (C-802)
Length: 6.39 m (ground/ship), 5.3 m (air)
Body diameter: 0 36 m
Launch weight: 715 kg (ground/ship), 555 kg (air)
Payload: Single warhead; 165 kg
Warhead: HE
Guidance: Inertial and active radar
Propulsion: Solid-propellant boost and turbojet
Range: 120 km (ground/ship), 130 km (air), 180 km (YJ-21)
Accuracy: n/k

Contractor

Chinese State Factories, but marketed by CPMIEC, Beijing.

HN-1/-2/-3 (X-600)

Type

Short- and intermediate-range, ground-, ship-, submarine-, air-launched, turbojet powered, single warhead, cruise missiles.

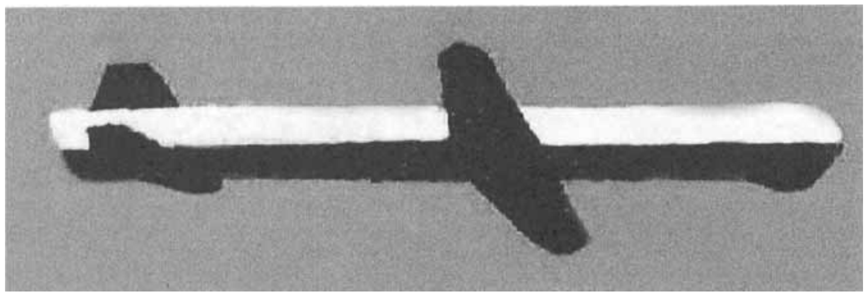
Development

Some reports suggest that the Chinese started a development programme around 1977 to develop a long-range cruise missile family. The missiles were required to carry a nuclear warhead for up to 3,000 km range. Initial development work was probably based on a design known as X-600, which had a design range of 600 km. The X-600 is believed to have used an HY-2 (Silkworm type) body, either a CAS-I 'Kraken' (YJ-6) or a CSSC-7 'Sadsack (HY-4). with a turbojet engine attached on a pylon at the rear of the missile underbody. The turbojet may have been fixed on the pylon, or it may have been retracted during carried flight on the aircraft. Flight trials were made using a modified B-6D bomber (Tu-16 'Badger') with the test missiles carried inside the bomb bay or mounted on the underwing pylons. It is possible that the initial design was known as XW-41, which was believed to be a modified HY-4 with extending wings mounted on the underside of the body. Alternatively, the initial design may have been known as the YJ-61, a modified YJ-6. The development programme is believed to have been directed by the No.1 Research Institute, which had been called the Hai-Ying Electro-Mechanical Technology Academy, and had already developed the Hai-Ying family of short-range cruise missiles. The 8359 (possibly also known as the 066) Research Institute and the Cruise Missile Institute of China were established in the mid 1980s to centralise all cruise missile developments, and it is assumed that these now control the design work for the subsequent missile programmes. It is reported that the manufacturing of cruise missiles is carried out at the No 7 Machine Building Factory. The first test flight of X-600 was made in 1985, using a small turbojet engine especially developed for the project. This missile is believed to have had terrain-following radar and an optical correlation terminal seeker. It is reported that development testing began in 1988 of an improved design, which was given the Chinese designator Hong-Niao-1 (Red Bird-I). This missile has a range of 600 km and is believed to use an airframe similar in shape and size to the Russian AS-15A 'Kent' (Kh-55) and SS-N-21 'Sampson' (3M10) and to the American RGM-109 Tomahawk cruise missiles. There are two versions of the HN-1 missile; the HN-1A, which is ground-launched, and the HN-1B, which is air-launched. The HN-1 missiles began operational evaluation in 1992, and it is believed that they entered service around 1996.

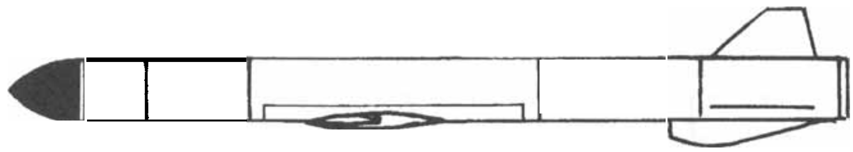
Development of a longer range HN-2 missile followed, with three versions of this missile. It is believed that conformal fuel tanks were added and an improved turbofan engine used to give longer range, similar to those used on the Russian AS-15B version. It is reported that the design of HN-2 was largely based on US Tomahawk technologies, recovered from crashed missiles. A US report gave the designator for HN-2 as YH-4, but this has not been confirmed. HN-2A and HN-2B are both believed to be ground- or ship-launched cruise missiles with a range of 1,800 km, and HN-2C is a submarine-launched version with a range of 1,400 km. There is a report of a submarine test launch being made in 1995, but this may have been of another missile. HN-2 is believed to have started operational evaluation in 1998.

A third version, HN-3, is now in development, with a range increased to 3,000 km. This missile can be ground-, ship-, or air-launched, and it is possible that a separate submarine-launched version will also be developed with a reduced range. It is possible that this missile uses technologies based upon the Russian AS-15B 'Kent' missile, integrated with tomahawk technologies. The first test flight of HN-3 was reported in June 1999. An unconfirmed report suggested that a fourth version was also being designed, HN-2000, with a maximum range increased to 4,000 km and capable of supersonic cruise at high altitude.

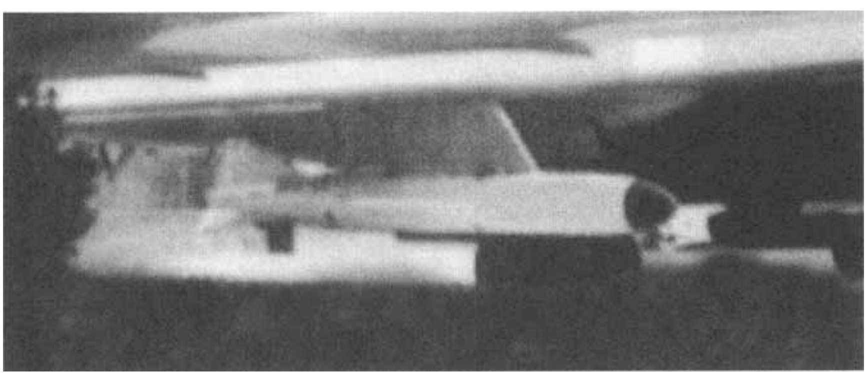
The HN family of missiles appears to be developed for a wide variety of roles, with nuclear, high explosive and submunition warheads. Vertical launch capsules are being designed for use on ships and submarines, and it is possible that an encapsulated version has been successfully launched from standard 533 mm torpedo tubes. It is expected that HN missiles could be carried by 'Song' class (type 039). 'Kilo' class (type 877EKM/636) and the new type 093 submarines, and could be fitted to 'Luhai' and 'Luhu' class destroyers. The ground-launched versions could be carried by wheeled TEL vehicles, as the Chinese have displayed some large vehicles for ballistic missile TELs, and several of these vehicles could be adapted to carry four to six cruise missiles. Initial flight tests on the X-600 prototype were carried out using a modified B-6D bomber, and it is reported that some 25 of these are being upgraded to carry HN family missiles. In addition, it is possible that one or two missiles could be carried by JH-7 (B-7). J-8IIM or Su-27 and Su-30 'Flanker' (J-11) aircraft.



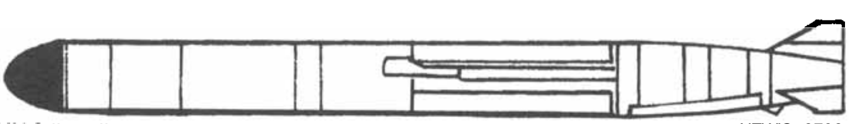
A HN-1 missile during a test flight NEW/0059917



***HN-1* line diagram** NEW/0137929



A trials X-600 missile, possibly a YJ-61, with wings folded and engine inlet retracted NEW/0059918



HN-2 line diagram NEW/0137931

Description

The HN-1 missile has a square shaped body, with two under-body mounted straight wings, a low tailplane and a vertical fin on the upper side. The wings, tail and fin unfold after launch. The air inlet for the turbojet engine is under the body at the rear of the missile, with the exhaust from the boat tail. The missile is believed to be 6.4 m long, and 7.2 m long with a tandem mounted boost motor. The body diameter is around 0.5 m, the wing span 2.5 m and the launch weight is reported to be 1,000 kg. The boost motor assembly weighs around 200 kg, giving the HN-1A ground-launched missile a launch weight of 1,200 kg. The boost motor assembly is jettisoned after use. It is believed that the payload weight is 400 kg, and that a 20 to 90 kT nuclear warhead, an HE warhead and a submunitions warhead are all options. A report in 1995 stated that China was developing 5 kg submunitions, with around 50 carried by a cruise missile. NORINCO has developed and offered for export several submunitions for use in cluster bombs since the early 1990s, and some of these could be used in the HN-1. Type 1 HE fragmentation submunitions weighing 5 kg, runway cratering submunitions weighing 20 kg, anti-armour submunitions with an IR sensor weighing 4.5 kg firing a shaped charge through top armour, small submunitions containing 765 steel balls, and fuel-air explosive submunitions could all be carried by HN-1 missiles. Mid-course guidance is reported to be provided by an INS/GPS system, with terrain comparison updates provided by a N seeker. A radio altimeter is used for terrain following. Terminal guidance is by terrain comparison, using the same TV correlation system backed-up by a low-light level system for use at night. An accuracy of 15 to 20 m CEP has been reported. China has bought and developed several UAV that could be used to gather radar and optical pictures of intended targets, plus satellite pictures. The missile is powered by a turbojet engine, possibly with the Chinese designator W40. The ground-launched HN-1A has a tandem-mounted solid propellant boost motor that accelerates the missile up to around M 0.6, when the turbojet engine starts and takes over for the mid-course and terminal phases. The missile cruises at around M 0.8 at an altitude of 20 m. The minimum range of the HN-1 is probably around 50 km, the maximum range of the ground-launched version is 600 km, and the maximum range of the air-launched version 650 km when released from medium level (10 km altitude). The HN-1A version is ground-launched from a wheeled TEL vehicle, but the type of vehicle is unknown. The HN-1B is air-launched from B-6D bombers, with two or three missiles carried per aircraft.

HN-2 has several improvements over the earlier HN-1 versions. Two conformal fuel tanks are reported to have been added either side of the body, in a similar way to that used by the Russian AS-15B. A turbofan engine was developed for the HN-2 missile, believed to be based on the Russian Omsk OKB-designed TRDD-50 engine used in the SS-N-21 and AS-15 missiles, and manufactured in China from 1992. China has also had the opportunity to examine in detail several US-made RGM/UGM-109 Tomahawk cruise missiles that have malfunctioned and crash landed, following the extensive use of these missiles in Iraq, Bosnia, Serbia, Kosovo, Afghanistan and Sudan. A wide range of improved technologies have been made available, including INS/GPS guidance, computer hardware and software, electronics, power supplies, airframe, wings, fuel systems and small turbofan engines. The payloads and guidance of HN-2 is believed to be similar to that used by HN-1, but with the body diameter increased to 0.7 m and the launch weight increased to 1,400 kg including the tandem-mounted boost motor. The wing position on HN-2 has been changed, to a mid-body position. The HN-2A and -2B versions are ground- and ship-launched missiles with a maximum range increased to 1,800 km. HN-2C is a submarine-launched version, believed to be launched through the 533 mm torpedo tubes using a launch capsule, with a range of 1,400 km. An accuracy of 5 m CEP has been reported.

HN-3 is believed to have had its maximum range increased to 3,000 km, and to have had further improvements. This version is reported to have a higher cruise speed of M 0.9, and to cruise at between 10 and 20 m altitude. The body diameter has been increased to around 0.75 m, and the launch weight, including the tandem-mounted boost motor, has been increased to 1,800 kg.

HN-2000 is believed to be in design, with a supersonic cruise option at high level, and a maximum range increased to 4,000 km.

Operational status

The development work on the Hong-Niao family of cruise missiles is believed to have started in 1977, with design of a prototype known as X-600. The HN-1 missile was first flight tested in 1988, operational evaluation started in 1992, and it is believed that the missiles entered service in 1996. An air-launch was reported in June 2001. HN-2 started flight tests in February 1995, with four tests reported up to October 1997, and it is believed to have entered operational evaluation in 1998. A ground launched HN-2 was tested in August 2001. HN-3 was first flight tested in June 1999. There are no reported exports of any of the three versions.

Specifications

Length: 6.4 m (7.2 m including boost motor)
Body diameter: 0.5 m (HN-1), 0.7 m (HN-2), 0.75 m (HN-3)
Launch weight: 1,200 kg (HN-1), 1,400 kg (HN-2), 1,800 kg (HN-3)
Payload: Single warhead
Warhead: 20 to 90 kT nuclear, 400 kg HE or submunitions
Guidance: INS/GPS with tercom and N correlation
Propulsion: Turbojet (HN-1), turbofan (HN-2/-3)
Range: 600 km (HN-1A), 650 km (HN-1B), 1,400 km (HN-2C), 1,800 km (HN-2A/B), 3,000 km (HN-3)
Accuracy: 15 to 20 m CEP (HN-1), 5 m CEP (HN-2/3)

Contractor

The development programme is believed to be directed by the 8359 (or 066) Research Institute and the Cruise Missile Institute of China. Manufacture is reported to be by the No 7 Machine Building Factory. The exporting of missiles is being managed by CPMIEC, Beijing.

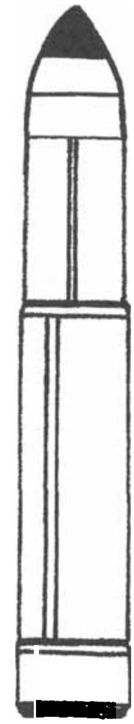
JL-2 (CSS-NX-5)

Type
Inter-continental-range, submarine-based, solid-propellant, single warhead ballistic missile.

Development
Little is known of the development of this missile, believed to have the Chinese designator Ju Lang-2 (JL-2 or Giant Wave-2). developed as a second-generation Submarine-Launched Ballistic Missile (SLBM) with a longer range than JL-1. It is believed that the NATO designator for this new missile is CSS-NX-5, although it is sometimes reported as CSS-NX-4, and the CSS-NX-5 designator was applied to the earlier FL-2 missile. The JL-2 has been designed for the follow-on class to the 'Xia' submarine, known as the Type 094 SSBN; four to six boats are planned, each carrying 16 or 18 missiles. Initial design of the JL-2 ballistic missile is thought to have started in 1970, with a range requirement of 6,000 km and a payload of 1,000 kg. JL-2 was being developed together with a land-based ICBM known as Dong Feng-23 (DF-23). A 2.0 m diameter solid-propellant motor was first tested in 1983. However, the operational requirement was changed in 1985, increasing the range to 8,000 km. The changes were probably to take advantage of the Chinese ability to build smaller nuclear warheads. At the same time, the land-based version designator was changed to DF-31 and, as the new submarine design for JL-2 was delayed, it was decided to develop the DF-31 missile first to replace the aging CSS-3 (DF-4) missiles. A successful ground launch of DF-31 was made in 1995 from the Wuzhai test centre. A simulated SLBM test was reported in October 1997, just testing the cold launch system from the canister. A first-stage motor test of DF-31 followed in July 1999, a second flight test was made in August 1999, with two further tests in November and December 2000. JL-2 is reported to be similar to DF-31, and may well be identical, as this joint development approach was used with the JL-1 and DF-21 systems. The DF-31 missile is described in a separate entry. A report in 1999 suggested that the single 'Xia' submarine in service had been modified to carry JL-2 missiles, but it is possible that the modifications were to carry the upgraded JL-1A (or JL-21A) missiles.

Description
JL-2 is a three-stage solid-propellant missile, believed to have a length of 13.0 m, a body diameter of 2.0 m, a launch weight of 52,000 kg and a payload of between 1,050 and 2,800 kg. The missile will be cold launched from its canister, with 16 or 18 missiles mounted vertically in the Type 094 submarine. The warhead will separate from the third stage after motor burnout, and will carry either a single warhead or 3 to 8 MIRV with decoys and penetration aids. The single nuclear warhead version is believed to have a yield of 1 MT, with the MIRV warheads having selectable yields of 20, 90 or 150 kT. The smaller warheads are reported to be similar to the US designed W88. The MIRV are believed to be around 1.75 m long, with a base diameter of 0.55 m, and a weight of 250 to 300 kg each. It is reported that the 13th Institute (Inertial Guidance) has been researching star trackers to update inertial guidance systems since the mid-I970s. and that stellar navigation and GPS updates will be used in the JL-2 design. An accuracy of 300 m CEP has been suggested for JL-2, although other reports suggest 150 m. The missile is believed to have a minimum range of 2,000 km and a maximum range of over 8,000 km.

Operational status
JL-2 is expected to enter service around 2005, some six years after DF-31. A report in 1999 stated that the converted 'Golf class trials submarine had been modified to test launch JL-2 missiles, and it was expected that the first launch would be carried out in 2000 or 2001. A planned launch was reported in September 2001, but this was cancelled. It is expected that four to six Type 094 nuclear powered submarines will be built, with the first of class commissioned around 2005. It is expected that the first operational launch of a JL-2 missile from the Type 094 submarine will be made in 2006/07. Each boat is expected to carry 16 to 18 missiles, and it is believed that a total of 70 to110 missiles will be built. Following the refit of the 'Xia' class submarine, which was completed in 2000, it is possible that this boat may carry JL-2 missiles, although it is believed that the refit was to enable JL-1A missiles to be carried.



Line diagram of JL-2 missile ***NEW***/0137930

Specifications
Length: 13.0 m
Body diameter: 2.0 m
Launch weight: 52,000 kg
Payload: Single or 3 to 8 MIRV warheads, 1,050 to 2,800 kg
Warhead: Nuclear 1MT or 3 to 8 MIRV with selectable 20, 90 or 150 kT
Guidance: Inertial with stellar updates and GPS
Propulsion: 3-stage solid propellant
Range: 8,000 km
Accuracy: 300 m

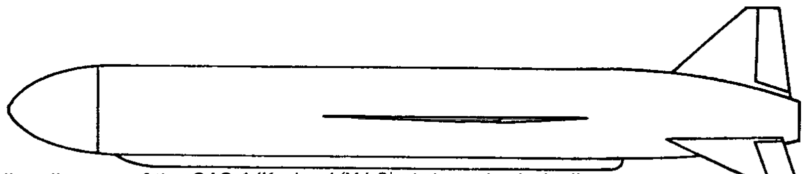
Contractor
It is believed that JL-2 was designed and developed by the First Academy of the Ministry of Aerospace Industries, now the China Aerospace Industry Corporation, Beijing. Flight testing is being carried out by the 2nd Artillery Corps at the Wuzhai test centre. The solid-propellant motors are believed to have been designed by the 401st Institute for SLBM Motors.

CAS-I 'Kraken' (YJ-6/YJ-62/YJ-63/C-601/C-611)

Type
Short-range radar guided air-to-surface missile.

Development
The development of the CAS-I missile is believed to have been carried out from 1975-84, with the objective of producing an air-to-surface missile system for attacking large ship targets. The design is based upon the former Soviet P-21, known as SS-N-2C 'Styx', surface-to-surface missile system, but developed in China as the Hai-Ying 2. CAS-I is an air-launched version of the HY-2 coastal defence anti-ship missile (NATO designator CSSC-3 'Seersucker'). NATO has given the designator CAS-I 'Kraken' to the air-to-surface missile, called C-601 when advertised for exports by the Chinese. The Chinese designator for this missile is Ying Ji-6 (YJ-6). A YJ-61 version has been reported, but this is believed to have been a demonstrator prototype for the X-600 missile, which later became the HN-1 cruise missile programme. It is reported that an extended range version of CAS-I, known as YJ-62 or C-611, was developed. However, it is possible that C-611 is the export designator for the turbojet-powered HY-4. A further version, with the designator YJ-63, was reported in 2000, and this is believed to have a TV seeker similar to that used on the C-701 missile, and the YJ-63 will be used to attack land targets. The YJ-6 missile has been cleared for carriage by the Xian H-6 bomber (B-6D version), the Chinese version of the Tu-16 'Badger', with two missiles carried on outboard underwing pylons. The missile-carrying aircraft has a distinctive cylindrical chin radome housing the acquisition radar. The B-6D modified aircraft have a digital computer KS-6, and use the ZJ-6W aircraft fire-control unit for the YJ-6 missiles.

Two CAS-1 (YJ-6) air-to-surface missiles carried under the wings of a Xian H-6 aircrafi



A line diagram of the CAS-1 'Kraken' (YJ-6) air-launched missile

Description
YJ-6 has two clipped-tip delta wings at mid-length and triform rudder and tailfins at the rear. The missile is 7.36 m long, has a body diameter of 0.76 m and weighs 2,440 kg. The missile has an inertial navigation system for mid-course, augmented with a Doppler radar navigator, located just forward of the tailfin assembly and a radio altimeter from the HY-2G missile. Terminal guidance is provided by an active X-band (8 to 10 GHz) monopulse radar. Before launch, the target co-ordinates are passed to the missile, together with the programme flight path. There are no post-launch updates. Following its release from the aircraft, the missile glides down towards the target until it reaches an altitude of 850 m, when the liquid-propellant rocket motor ignites. This motor is believed to use UDMH and kerosene, pressurised by compressed air and fed through a turbopump. The motor has two thrust levels, to accelerate the missile after launch and then to maintain the cruise speed and altitude. The YJ-6 can cruise at preset altitudes of 50, 70 or 100 m, using a radar altimeter, and maintains a cruise speed of M0.9. A large Semi-Armour-Piercing (SAP) blast/fragmentation 513 kg warhead is fitted to YJ-6, and at the end of the terminal phase the missile dives down onto the target ship. The missile is believed to have a range of 110 km when launched from medium altitude (30,000 ft), and a minimum range of 25 km. The missile can be launched from altitudes between 1,000 and 9,000 m (3,000 to 30,000 ft). The YJ-62 version is reported to have a range of 200 km. The TV-guided YJ-63 land-attack missile version is reported to have a maximum range of 100 km, and to cruise at around 300 m altitude.

A C-601 export version of CAS-1 air-to-surface missile under an H-6 aircraft 0003135

Operational status
The YJ-6 (CAS-I 'Kraken') is believed to have started in production around 1983, and to have entered service in 1985. There are unconfirmed reports that C-601 missiles have been exported to Iraq and Iran. The YJ-62 version is thought to have entered service in 1989. China is believed to have modified 30 H-6 bombers to the B-6D standard to carry the YJ-6 missiles. Reports in 1996 indicated that most of the H-6 aircraft were not being flown, and as it is unlikely that the YJ-6 or YJ-62 missiles would be carried by the Su-27 'Flanker' aircraft, it is assumed that between 150 to 200 missiles may be stored for emergency use. However, a report in 2000 suggested that 25 B-6D aircraft would be upgraded to carry two or four YJ-63 missiles, and that 200 missiles would be converted to the YJ-63 standard by 2005.

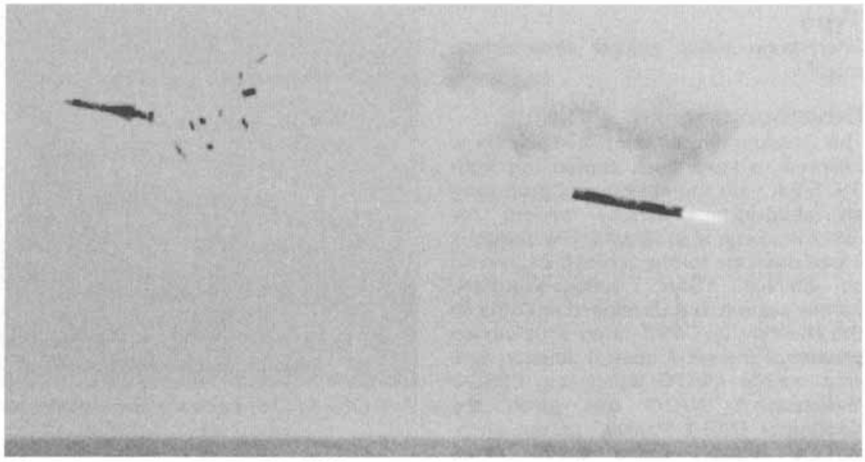
Specifications
Length: 7.36 m
Body diameter: 0.76 m
Launch weight: 2,440 kg
Payload: Single warhead
Warhead: 513 kg HE SAP blast/fragmentation
Guidance: Inertial and active radar terminal
Propulsion: Liquid propellant
Range: 110 km (YJ-6). 200 km (YJ-62)
Accuracy: n/k

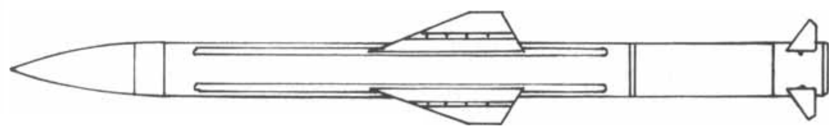
Contractor
Chinese State Factories; but marketed by CPMIEC, Beijing (prime contractor).

MM 38/40, AM 39 and SM 39 Exocet

Type
Short-range, ship-, air-, ground- or submarine-launched, solid-propellant, single warhead surface-to-surface and air-to-surface missiles.

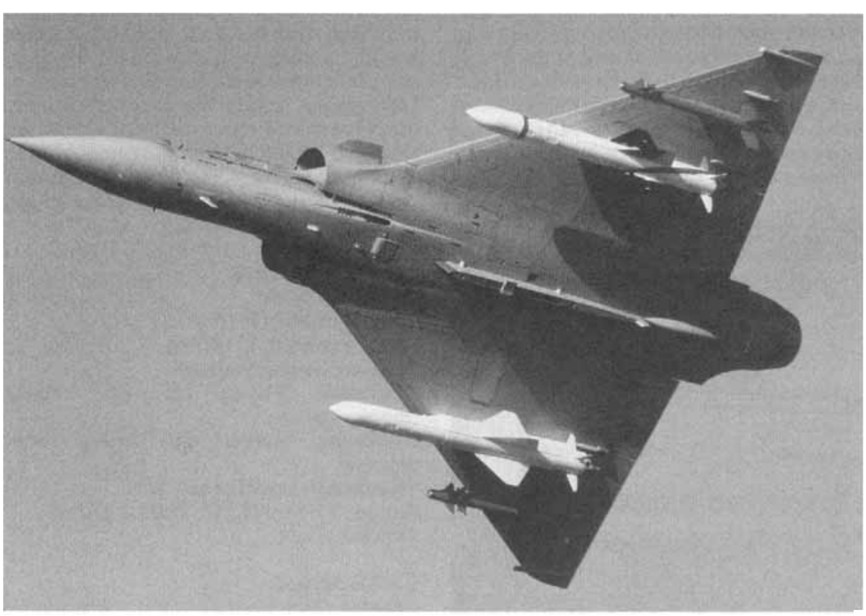
Development
Exocet missiles were designed to attack large warships. Their development started in 1967, originally as the ship-launched variant MM 38 that entered service in 1975. AM 39, the air-to-surface version, was developed later, work starting in 1974 before it entered service with the French Navy in 1979. Development started on an improved version of the MM 38 in 1976, designated the MM 40. Development was complete in 1980 and full-scale production started in 1981. An upgraded version known as AM 39/MM 40 block 2 was developed and entered service in 1992. This version has digital computing in the active radar seeker, guidance and control systems, with improvements to the sea-skimming altitude control and the ability to manoeuvre in the terminal phase. Further upgrades to the MM 40 missiles have been developed, the block 2 mod 1 has a laser gyro INS and an upgraded seeker. Mod 2 has been proposed as a land-attack cruise missile version, with a digital guidance computer and GPS. A further mod 3 version has also been proposed using a new active radar seeker with target recognition and aim point selection. A block 3 missile design was proposed in May 2002, with a turbojet engine and a maximum range of 200 km.


The submarine-launched SM 39 Exocet missile, shortly after broaching the water and leaving the launch capsule (VSM) after a submerged firing


A line diagram of the MM 40 Exocet missile

Development of the SM 39 (submarine-launched version of the AM 39) started in 1979 and was completed in 1984. This was later upgraded to the block 2 standard. There have been coastal defence variants developed for both MM 38 and MM 40 missile systems, and these have the designators BC 38 and BC 40. The MM 38 is fitted: in six-launch canisters, to the helicopter carrier *Jeanne D'Arc* and the 'Tourville' class destroyers; in four-launch canisters to the 'George Leygues' and 'Suffren' class destroyers and frigates of the 'Commandant Riviere' class; and in two-launch canisters in the 'D'Estienne D'Orves' and 'Floreal' class frigates.

The MM 40 is fitted in eight-launch canisters to Type F 65 and 'George Leygues' class destroyers, and 'La Fayette' and 'D'Estienne D'Orves' class frigates with four-launch canisters. The SM 39 is fitted to submarines of the 'Le Triomphant', 'L'Inflexible', 'Rubis' and 'Agosta' classes. MM 38/40 missiles are fitted to similar vessels of other countries and to fast attack craft of various types. The AM39 (air-launched version) Exocet has been cleared for carriage on Super Etendard, AMX, Mirage F1, Mirage 5, Mirage 2000, Jaguar, and Atlantique aircraft, and on Sea King, Super Frelon and Super Puma helicopters.


*Two AM 39 Exocet missiles carried on the inner wing pylons of a Mirage 2000 **N** aircraft* (Aerospatiale) 0022178

Description
The Exocet family of missiles are all the same basic shape, only the length and wing shape alter for the different types. They have four clipped delta-wings at mid-body and four raked clipped-tip moving delta control fins at the rear. The MM 38 is 5.21 m long, has a body diameter of 0.35 m and a launch weight of 735 kg. Guidance in the mid-course phase is inertial, provided by one axial and one vertical gyroscope operating in conjunction with three accelerometers. Coupled with the radio altimeter, this inertial platform allows the missile to fly a sea-skimming trajectory to the target. Terminal guidance is by an ADAC Mk 1 active radar. At the end of the launch phase, which differs with the type of launcher, the missile is stabilised in the direction of the target at its first cruise altitude. This altitude satisfies a dual requirement in that, while being low enough to avoid detection by the target, the missile is still high enough to allow its active radar seeker head to acquire the target. The missile descends to its second cruise altitude for the terminal phase, with a final approach at an altitude determined by prevailing sea conditions, but which can be as low as 3 m. The warhead is a shaped charge high explosive fragmentation type, with a weight of 165 kg, designed to penetrate the target ship's hull before exploding inside the ship. All versions of the surface-to-surface Exocet are installed in a watertight tube container with folded wings; these containers are also the launch

Specifications

	MM 38	MM 40	SM 39	AM 39
Length	5.21 m	5.8 m	4.69 m	4.69 m
Body diameter	0.35 m	0.35 m	0.35 m	0.35 m
Launch weight	735 kg	870 kg	655 kg	670 kg
Payload	165 kg	165 kg	165 kg	165 kg
Warhead	HE fragmentation	HE fragmentation	HE fragmentation	HE fragmentation
Guidance	Inertial with active radar	Inertial with Active radar	Inertial with active radar	Inertial with active radar
Propulsion	Solid propellant	Solid propellant	Solid propellant	Solid propellant
Range	40 km	70 km	50 km	70 km
Accuracy	n/k	n/k	n/k	n/k

tubes. MM 38 has solid-propellant motors: the Vautour boost motor weighs 100 kg, has two exhaust nozzles, and burns for 2.4 seconds. The Epevier sustainer motor weighs 151 kg, exhausts through a central nozzle that passes through the boost motor chamber and burns for up to 93 seconds. The missile has a maximum range of 40 km.

MM 40 Exocet is 5.8 m long and weighs 870 kg at launch. The additional length, compared to MM 38, provides the MM 40 with more propellant and results in an increased maximum range of 70 km when supported by over-the-horizon targeting data from aircraft, helicopters or ships nearer to the target than the launch platform. MM 40 Exocet block 2 has a new ADAC Mk 2 active monopulse frequency-agile radar with a TWT amplifier. Digital processing provides a more flexible ECCM capability and delayed seeker emissions. Upgraded inertial navigation and control systems enable block 2 missiles to fly at 2 or 3 m altitude and to make preprogrammed manoeuvres, as well as improving discrimination among multiple targets, decoys and coastal features. Several missiles can be launched on different profiles and routes to saturate defences. The block 2 mod 1 missiles have an improved INS and upgraded active radar seeker.

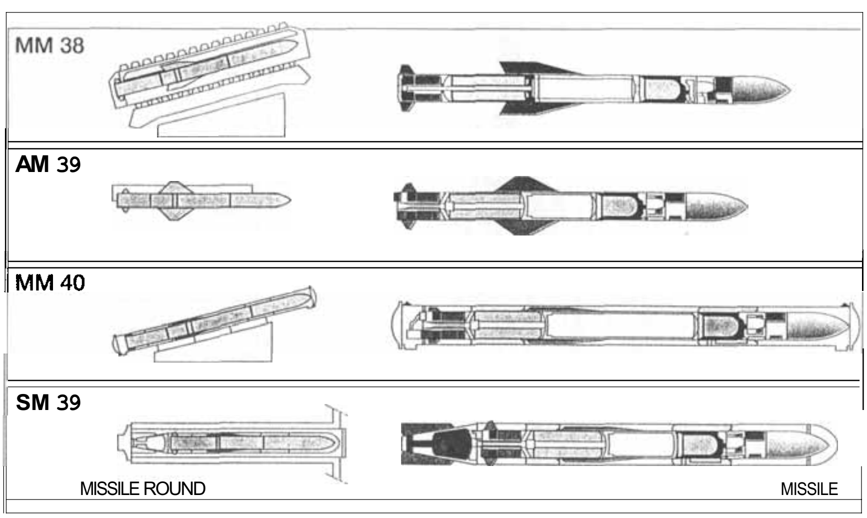
SM 39, the submarine-to-surface version, is stored in a container-launch module along with propulsion and guidance units (designated VSM (*Véhicule Sous-Marin*)) and fired from standard torpedo 533 mm launch tubes. The missile has a length of 4.69 m and weighs 655 kg, but the missile and VSM together weigh 1,345 kg. After breaking the surface, the missile separates from the VSM vehicle at low altitude (30 m) to ensure low launch signature. Missile operation is then the same as other versions of Exocet. The maximum range of the SM 39 is reported to be 50 km.

A trials launch of an MM 40 Exocet missile from the frigate La Fayette (DGA/CEL)

AM 39 Exocet is 4.69 m long, has a body diameter of 0.35 m and a launch weight of 670 kg. This missile has a wingspan of 1.1 m. AM 39 has a maximum range of 50 km from low level, but a range of up to 70 km has been reported for high-altitude (over 10 km or 30,000 ft) releases.

Operational status

MM 38 Exocet missiles entered service in 1975 and production is said to be complete. AM 39 entered service in 1979 and is still in production. Block 2 improved versions entered service in 1992. MM 40 entered service in 1981 and is still in production, with MM 40 block 2 missiles reported to have entered service in 1992, and block 2 mod 1 missiles in service from 2000. SM 39 entered service in 1985. The total number of Exocet missiles built is reported to exceed 3,200, with 1,260 MM 38, 700 MM40, 1,100 AM 39 and 130 SM 39. Pakistan ordered SM 39 missiles in 1995 for use from its Khalid (Agosta) class submarines, and fired the first test missile in March 2001. Both ground-launched and ship-launched versions of Exocet, the MM 38 and MM 40, have been exported to many countries, including Argentina, Bahrain, Belgium, Brazil, Brunei, Cameroon, Chile, Colombia, Cyprus, Ecuador, Germany, Greece, Indonesia, Iraq, Ivory Coast, South Korea, Kuwait, Malaysia, Morocco, Nigeria, Oman, Pakistan, Peru, Qatar, Saudi Arabia, Taiwan, Thailand, Tunisia, UAE, UK and Uruguay. In 2000, South Africa placed an order for MM 40 missiles to be fitted to A-200 MEKO class corvettes, and in 2001 Turkey fitted MM 38/40 missiles to ex-French type A69 frigates. An MM 38 coastal defence missile was used to damage HMS *Glamorgan* in the Falkland/Malvinas conflict in 1982. AM 39, the air-launched version, has been exported to Argentina, Brazil, Egypt, Greece, India, Iraq, Kuwait, Libya, Oman, Pakistan, Peru, Qatar, Saudi Arabia, Singapore, South Africa, UAE and Venezuela. The AM 39 has been used in several conflicts: four were launched by Argentina in the Falkland/Malvinas conflict in 1982; and over 100 were launched by Iraq in the war against Iran between 1980 and 1988. Two AM 39 missiles were fired from an Iraqi Mirage F1 damaging USS *Stark* in 1987. The Block 2 version was trialled from Atlantique 2 and Super Etendard aircraft in 1993.



Diagrams of the four Exocet missile versions and their respective canisters (Aerospatiale)

Contractor

MBDA (part of EADS), Chatillon-sous-Bagneux.

M-4/ M-45

Type

Intermediate-range, submarine-launched, solid-propellant, Multiple Re-entry Vehicle (MRV) capable ballistic missiles.

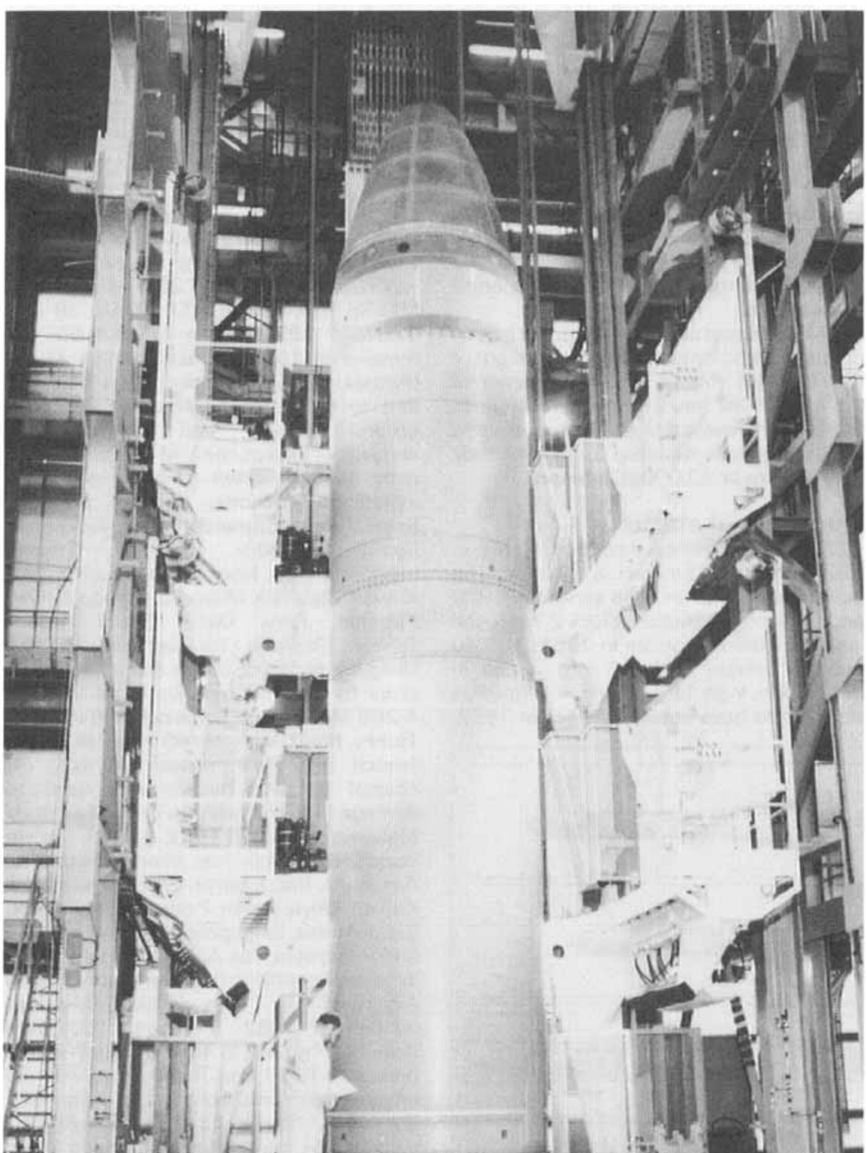
Development

The first-generation French Submarine-Launched Ballistic Missile (SLBM), the M-1, became operational in 1971. This was replaced by the M-2 in 1974, and by the M-20 in 1977. The M-20 was a two-stage missile, with a single 1 MT nuclear warhead, and a range of 3,000 km. The M-4 was the fourth missile in the MSBS (*Mer-Sol-Balistique-Stratégique*) family. Initial development work for the M-4 was carried out using the test boat *Le Gymnote,* using twin tubes for the tests. The first test launch took place in November 1980 on the Landes test range, the 14th and final test firing taking place from *Le Gymnote* on 29 February 1984. The principal qualitative improvements in the M-4 over its predecessor, the M-20, were in range and payload, the M-4 being upgraded to include multiple re-entry vehicles. There are reported to be two versions of the M-4 missile in service, the M-4A with a range of 4,000 km and the M-4B with a range of 5,000 km. In March 1986, a French boat fired an M-4 over a distance of 6,000 km; the payload for this flight is not known and it is believed that this might have been a first test of the longer range M-45 version. Proposals were made in 1988 to adapt a variant of the M-4 missile for land basing to replace the S-3, but this was not pursued. The M-4 missiles are carried by the *L'Inflexible* class, formerly known as the *Le Redoutable* class, with two Nuclear-Powered Ballistic Missile Submarines (SSBN) remaining in service and each carrying up to 16 missiles. Logistical support for the MSBS fleet is provided by the Ile Longue naval base in Brest Bay, where the assembly and storage facilities are located.

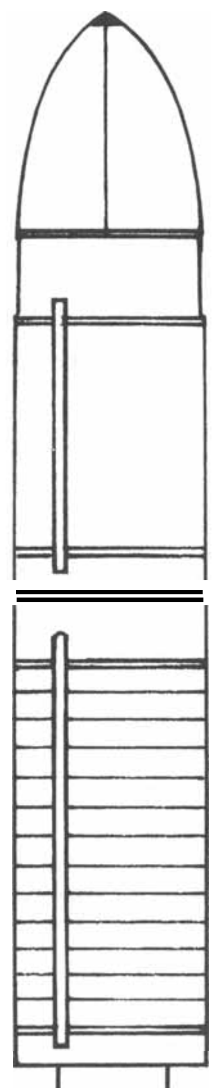
The M-45 is a 6,000 km range improved version of the M-4 missile. In 1994, plans were announced to examine the option of replacing the 18 S-3 missiles in silos on the Plateau d'Albion with M-45 missiles, but this proposal was dropped in 1996 when it was decided that the S-3 missiles would not be replaced. M-45 SLBMs are being fitted into the first three *Le Triomphant* class submarines, with 16 missiles carried in each boat, and *L'Inflexible* has recently completed a refit to enable it to carry M-45 missiles until it is replaced by the fourth *Le Triomphant* class boat.

Description

The M-4 missile is a three-stage, intermediate-range missile, 11.05 m long and 1.93 m in diameter. The launch weight is 35,000 kg; guidance is inertial. The first stage burns for 62 seconds, the second for 71 seconds and the third for 43 seconds.



A French M-4 missile being prepared for loading into a submarine (Aerospatiale)



A line diagram of an M-4 SLBM

The three-stage solid propellant motors contain 20,000 kg, 8.0 15 kg and 1,500 kg of propellant respectively. Each motor has a single flexible nozzle for control. The maximum range is 4,000 km for M-4A and 5,000 km for M-4B. and the minimum range is believed to be about 1,500 km. The payload has been increased to six re-entry vehicles, which are believed to have some independent targeting capability. This implies that there is some additional guidance system incorporated within the delivery system. The initial TN-70 nuclear warheads are believed to have been replaced with the later TN-71 warheads, which have a yield of 100 kT. Each re-entry vehicle is believed to weigh about 240 kg, with the TN-7 1 warhead weighing 120 kg. The payload is reported to include penetration aids. This would suggest a total payload capability of approximately 1,700 kg. An estimated accuracy of the M-4 missile system is 500 m CEP.

The M-45 missile has a length of 11.05 m, a body diameter of 1.93 m and a launch weight of 35,000 kg. The first stage has a weight of 20,000 kg, with a solid propellant motor, having a thrust of 70 tonnes controlled through a single steerable nozzle. The second stage has a weight of 8,000 kg, with a solid propellant motor having a thrust of 30 tonnes. The third stage has a weight of 1,500 kg and a solid propellant motor with a thrust of 7 tonnes. The M-45 version has up to six warheads, TN-75, each with an estimated yield of 100 kT. Each re-entry vehicle is believed to weigh 230 kg, with the TN-75 warhead weighing 115 kg. The payload is reported to include penetration aids. M-45 has a maximum range of 6,000 km and a minimum range of 2,000 km. An estimated accuracy for the M-45 missile is 350 m CEP.

Operational status

The M-4 missile entered service in 1985. The current MSBS force is based on nuclear-powered submarines, SNLE (*Sous-marines Nucléaire Lanceur d'Engins Balistique*), each able to carry 16 missiles. The M-4 is now only operational in *L'Indomptable,* which is expected to be withdrawn from service in 2004. It is believed that there are 96 M-4B missiles in service, but only one boat load (16 missiles) operational. Trials firings were made in 1992 and 1994. One SNLE boat has been taken out of service as each of the new SNLE-NG *Le Triomphant* class boats enter service with M-45 missiles. *L'Inflexible* was refitted in 1999/2000 to carry M-45 missiles, and is expected to remain in service until 2008.

The new TN-75 nuclear warhead for the M-45 missile was tested in October 1995, and this was believed to be the final qualification test in a long series that started in 1981. The first M-45 test launch was made in 1986 and further tests were made in 1991, two in 1993 and in 1995. A M-45 missile was fired by *L'Inflexible* in April 2001. The M-45 variant entered service in 1997, fitted to *Le Triomphant,* the first of four SNLE-NG (new generation) boats carrying 16 missiles each. The second boat in this class, *Le Temeraire.* entered service in 1999 and made a test launch of an M-45 missile in May 1999. The third boat, *Le Vigilant,* is expected to enter service in 2004. It is reported that there will be a total of 192 M-45 missiles built, but at present there are three boat loads (48 missiles) operational. The M-51 missiles, planned to replace the M-45, are now expected to enter service in 2008, with the first missiles being fitted to the fourth SNLE-NG boat.

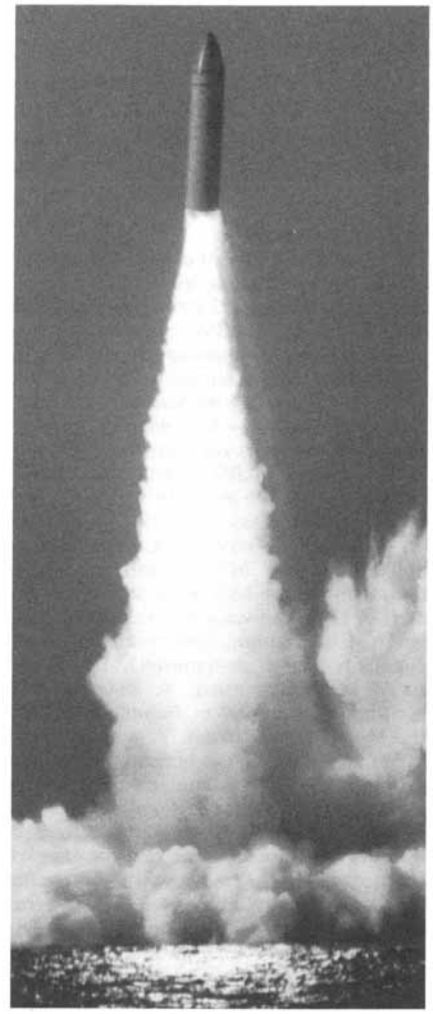
Specifications

M-4

Length: 11.05 m
Body diameter: 1.93 m
Launch weight: 35,000 kg
Payload: 6 re-entry vehicles in MRV configuration
Warhead: 100 kT nuclear each
Guidance: Inertial plus computer payload control
Propulsion: 3-stage solid
Range: 4,000 km (M-4A), 5,000 km (M-4B)
Accuracy: 500 m CEP

M-45

Length: 11.05 m
Body diameter: 1.93 m
Launch weight: 35,000 kg
Payload: 6 re-entry vehicles in MRV configuration



An M-4 SLBM being fired from L'Inflexible *during an operational test*

Warhead: 100 kT nuclear each
Guidance: Inertial plus computer payload control
Propulsion: 3-stage solid
Range: 6,000 km
Accuracy: 350 m CEP

Contractor

EADS Launch Vehicles, Les Mureaux (prime contractor).

M-5/M-51

Type
Inter-continental-range, submarine-based, solid propellant, MIRV capable ballistic missile.

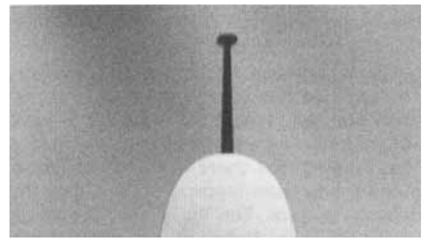
Development
The latest development of the MSBS (***Mer-Sol-Balistique-Strategique)*** family was to have been the M-5 Submarine-Launched Ballistic Missile (SLBM) planned for the four new Nuclear-Powered Ballistic Missile Submarines (SSBN) known in France as the SNLE-NG (***Sous-marines Nucléaire Lanceur d'Engins Balistique - Nouvelle Generation).*** The first three boats will carry the improved M-45 variant SLBM, until the M-51 becomes available in 2008 to 2010. The ***Le Triornphant*** class submarines are fitted with 16 SLBM launch tubes. Initial design studies for the M-5 started in 1992. Development of M-5 was scheduled to start in 1993 but was delayed until 1996, when it was announced that a reduced capability system, designated M-51, would be developed instead. A development contract was signed in August 1998 for the M-51 missile system. A proposal was made to develop a land-based version for location in the Plateau d'Albion as a replacement for the S-3 missiles but, in 1996, the French government announced that the S-3 missiles would be dismantled and not replaced. An unconfirmed report in 2000 suggested that the M-51 will use the existing third stage from the M-45 missile, and will only be fitted with four MIRV.

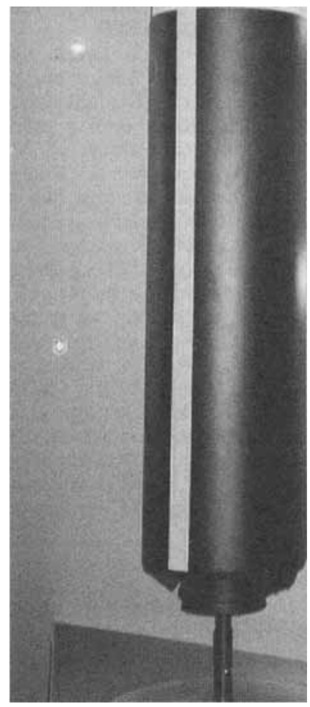
Description
The three-stage solid-propellant M-51 missile is to have a maximum range of 8,000 to 10,000 km, together with modern penetration aids capable of matching the perceived upgrades to the Moscow anti-ballistic missile system. It is believed that the missile will be around 13.0 m long, with a body diameter of 2.35 m and a launch weight of 50,000 kg. The solid-propellant motors will use carbon fibre cases and Butalene H propellant, with carbon-carbon nozzles mounted in control gimbals. A liquid-propellant system is being developed for the post-boost bus vehicle, to give greater flexibility in releasing the MIRVs. The payload has been reported as being up to six Multiple Independently Targetable Re-entry Vehicles (MIRV) using the TN-75 warheads developed for the M-45 missile with a yield of 100 kT, together with penetration aids. These warheads weigh 115 kg, and the complete RV has a weight of 230 kg. A later version is planned to carry improved TNO nuclear warheads, from about 2015.

Operational status
The M-51 missile is planned for introduction into service between 2008 and 2010, as a replacement for the M-45 SLBM, with development started in 1998. It is expected that the first M-51 missiles will be fitted to the fourth of the SNLE-NG boats of the ***Le Triornphant*** class, ***Le Terrible,*** with 16 missiles carried, and that it will then be retro-fitted into the other three boats. It is planned that 57 missiles will be built. The first ground test of the new M-51 first stage motor was made in May 1999. The first full flight test is planned for 2005, although elements of the M-51 launch control system were reported to have been tested in the M-45 test made in April 2001.

Specifications
Length: 13.0 m
Body diameter: 2.35 m
Launch weight: 50.000 kg
Payload: Up to 6 MIRV
Warhead: Nuclear 100 kT each
Guidance: Inertial
Propulsion: 3-stage solid
Range: 10,000 km
Accuracy: n/k

Contractor
EADS Launch Vehicles, Les Mureaux (prime contractor).





A model M-51 SLBM exhibited at Paris in 1999 (Duncan Lennox) 00139219

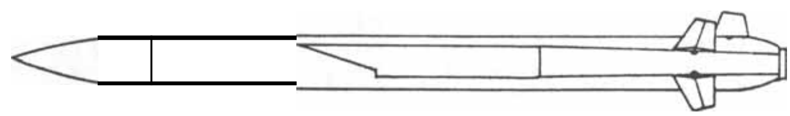
ASMP

Type
Short-range, air-launched, solid-propellant, single warhead air-to-surface missile.

Development
The ASMP *(Air-Sol Moyenne Portee),* medium-range ASM programme commenced in 1976, and full-scale development started in 1978. ASMP was designed to replace the AN-22 nuclear bomb carried by the Mirage IV, to give more credible penetration to heavily defended targets. Originally designed for carriage on the Mirage 2000N, the ASMP has also been cleared for the Mirage IVP and Super Etendard aircraft. However, in 1996, the Mirage IVP aircraft were removed from their nuclear role. An improved version of the ASMP was proposed in October 1987 by France for future joint development with the UK, as an airborne tactical nuclear weapon replacement for the UK's WE 177 nuclear bomb, but the UK cancelled this requirement in 1993. Aerospatiale (now MBDA, part of EADS) proposed a longer range missile, ASLP *(Air-Sol Longue Portée)* in 1991 with a range of 800 to 1,200 km. In 1993, a conventional warhead version of ASMP, known as ASMP-C or Asura, was proposed to both the French and UK governments for High Explosive (HE) standoff weapon requirements. ASMP-C would have used an AS 30L warhead with a weight of 240 kg and incorporate an Infra-Red (IR) terminal guidance seeker. Several ranges were quoted for this missile, from 250 to 400 km. A passive radar-guided version, known as ASMP-R, was proposed in 1994 for use against Airborne Early Warning (AEW) aircraft as a long-range air-to-air missile.

In 1995, a further variant, known as ASMP-Plus, was proposed as a lower cost alternative to ASLP, with a range of 500 km. This version is now known as ASMP-Ameliore (ASMP-A). The ASMP-A proposal was agreed in 1996 by the French Air Force, and is planned to enter service between 2008 and 2010 for use on Rafale and Mirage 2000N aircraft.

An ASMP missile carried under the fuselage of a French Navy Super Etendard aircraft (Aerospatiale) 0038244


A line diagram of the ASMP

Description
The ASMP is a short-range, inertial-guided, air-to-surface missile powered by a liquid-fuelled ramjet motor and armed with a nuclear warhead. It is cylindrical in shape with a pointed nose, with two rectangular ramjet motor air intake ducts on each side; with long inlet strakes running down the sides of the missile body. For aerodynamic reasons, the ducts run for about two-thirds of the body length to the aft end of the missile where they are tapered into the fuselage, and are thus able to house equipment such as servo-actuators for the cruciform clipped delta control surfaces surrounding the large exhaust nozzle. There is also a fixed vertical fin on the upper surface just behind the control fins.

The missile is 5.38 m long, has a body diameter of 0.38 m, a finspan of 0.96 m and a launch weight of 860 kg. It is reportedly fitted with a 300 kT nuclear warhead with a weight of 200 kg, the TN-80. The TN-81 warhead version is lighter in weight at 180 kg, and is believed to have been fitted to some of the later built missiles. Details of the fuzing system are not known. Guidance is by inertial reference and probably terrain-mapping, with an onboard computer which can be programmed before launch with target location, flight profile and track changes to evade fixed defences.

The Mirage 2000N uses the Electronic Serge Dassault (now Thales) Antilope 5 radar, which when operating in the ground-mapping mode, provides the target co-ordinates for the ASMP and feeds guidance information to the missile's inertial navigator. The initial boost after launch is provided by an integral solid-propellant motor, which is fired after the missile has dropped a safe distance from the launch aircraft. This motor accelerates the missile from its minimal launch speed of M0.6 to about M2.0 in 5 seconds. The complete combustion of the solid propellant is a critical phase in the transition from boost motor to ramjet as the booster cartridge has to be ejected out of the ramjet through its exhaust nozzle within a fraction of a second while the ramjet inlets open. Kerosene is supplied to the ramjet engine, which features a swirl-type combustion chamber, by pressurised tanks before start-up takes place. The missile cruises at high level (10 km) at M3.0, and at low level at M2.0. The ASMP is credited with a range of 250 km when launched from a high altitude, but low level launch is limited to 80 km range.

Operational status
The ASMP entered service with the French Air Force in 1986. It is reported that a limited production of 150 missiles was completed over a six year period (1985 to 1990). although it is believed that there are about 80 to 90 operational missiles in service. There have been no reported exports.

Specifications
Length: 5.38 m
Body diameter: 0.38 m
Launch weight: 860 kg
Payload: Single warhead 200 kg
Warhead: Nuclear; 300 kT
Guidance: Inertial and terrain mapping
Propulsion: Solid propellant boost and ramjet
Range: 250 km
Accuracy: n/k

Contractor
MBDA, Chatillon-sous-Bagneux (prime contractor).

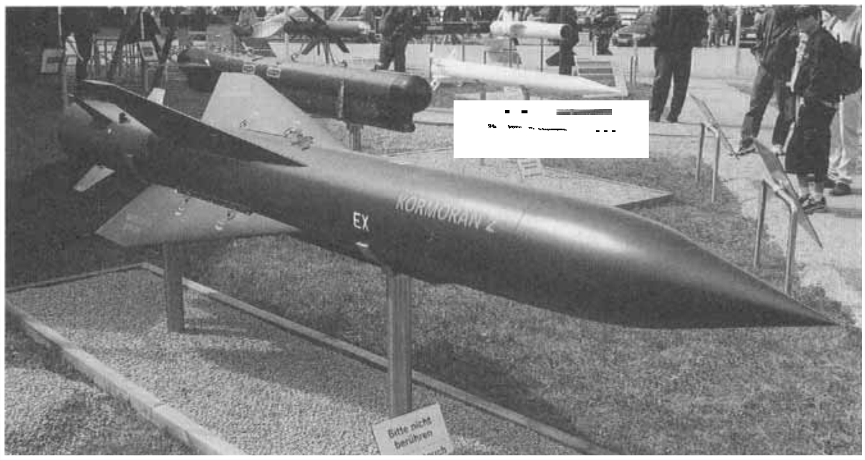
AS 34 Kormoran 1 and 2

Type
Short-range, air-launched, solid-propellant, single warhead, air-to-surface missiles.

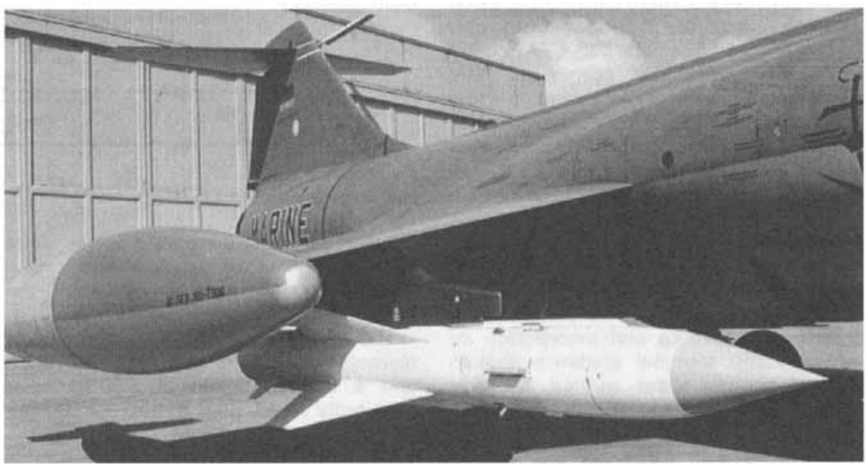
Development
The AS 34 Kormoran anti-ship, air-to-surface missile programme was started in 1962 when Bolkow KG was requested by the German Ministry of Defence to study air-to-surface missiles. Parallel studies were carried out by Nord Aviation (now MBDA, part of EADS) based on the AS 33 project jointly financed by France and Germany, and on seeker head studies by the Compagnie de Telegraphie sans Fils (CSF) now part of Thales. In 1967, Messerschmitt-Bolkow-Blohm (MBB) GmbH (now LFK and part of EADS) was appointed prime contractor and awarded the initial development contract. In accordance with German Navy requirements, the Kormoran system was designed for warfare in coastal waters and to be carried by the F-I04G Starfighter aircraft. Trials were completed by 1974, and a production contract was signed in 1976 calling for 350 AS 34 Kormoran 1 missiles and 56 F-104G Starfighter aircraft installations. Kormoran 1 entered service in 1977 and production continued until 1983. Although the French industry participated in the programme, France did not purchase AS 34 Kormoran 1. Kormoran 1 has been cleared for carriage on F-I04G Starfighter and Tornado aircraft.

Development of an improved version, Kormoran 2, for use on the Tornado started in 1983. This missile has: an improved warhead; digital electronics; an updated active radar seeker; more powerful booster motor; longer range; target selection; multiple launch capability and increased resistance to Electronic CounterMeasures (ECM). The new booster motor also enables Kormoran 2 to be launched from relatively slow aircraft such as the Atlantique.

The initial design phase for Kormoran 2 started in 1983, with design models tests in 1985 and the first flight and firing trials in late 1986. In December 1987, Kormoran 2 successfully completed the manufacturer's firing tests at Decimomannu in Sardinia. In 1989, it was reported that Kormoran 2 missiles were about to enter production and this version entered service in 1991. Kormoran 2 was cleared for carriage on F-I04G Starfighter and Tornado aircraft.



An AS 34 Kormoran 2 missile displayedin 1998 (Paul Jackson) 0038245



An earlyproduction AS 34 Kormoran I test missile fitted to a GermanFleet Air Arm F-104G Starfighter during firing trials in 1977

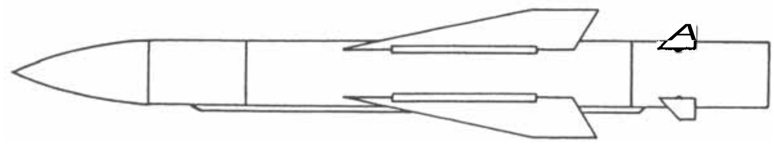

***Test** launch of an AS 34 Kormoran I missile from an Italian Air Force Tornado IDS aircraft*

Description
The AS 34 Kormoran 1 is a short-range, radar-guided ASM, powered by a solid-propellant motor and armed with a High Explosive (HE) shaped charge warhead. It is cylindrical in shape with a pointed nose, has four sharply swept clipped delta-wings just aft of mid-body and four moving clipped delta control fins at the rear. The missile is of modular construction and is made up of three major sections. The nose-section consists of a pointed radome, which covers the seeker's antenna, and the Thomson-CSF (now Thales) RE 576 active radar seeker. The warhead section contains the warhead, initiator and warhead safety and arming device. The remainder of the missile is the propulsion section, which consists of the two launch boosters and the sustainer motor. This section also contains: the central twin gyro platform; guidance computer; radar altimeter; power supplies and control actuators. The two solid-propellant booster motors are positioned on either side of the sustainer motor exhaust in the horizontal plane.

The Kormoran 1 missile is 4.4 m long, has a body diameter of 0.34 m, a wingspan of 1.0 m and a launch weight of 600 kg. It is fitted with a 160 kg shaped charge semi-armour-piercing warhead, which is detonated by a delayed-action impact fuze. Guidance in mid-course is inertial with the radar altimeter controlling the cruise height. Once a target is detected and identified by the launch aircraft's radar, target range and bearing are fed into the missile's navigation system. On release the missile free-falls from the launcher aircraft.

The twin solid-propellant boosters are ignited and accelerate the missile to about M0.9, at which point the solid-propellant sustainer motor ignites, burning for 100 seconds. At the end of the launch phase, the missile is stabilised in the direction of the target at a first cruise altitude, which is reported to be around 30m. At a predetermined distance from the target the inertial navigation system unlocks the active radar seeker head which commences scanning. After lock-on has been achieved the inertial guidance is slaved and corrected in azimuth and range by the seeker head and the missile heads for the target. At a short distance from the target the missile descends to its final flight level of about 3 to 5 m in order to hit the target just above the waterline. The missile also has a short range firing mode, with the active seeker activated shortly after launch. There is another mode of deployment called the optical mode of firing, in which the pilot aims at the target by means of his optical sight. This may be used against surprise targets, to counter jamming against the aircraft's radar, or in the case of defects in the aircraft's radar system. In this mode, the missile's active radar seeker is activated at launch. Kormoran 1 has a cruise speed of about M0.9, a minimum range of 8 km and a maximum range of 30km when launched from medium altitude (30,000 ft). Kormoran 1 must be launched at speeds greater than M0.6 and is normally launched at low level.

Kormoran 2 has the same basic airframe as Kormoran 1, but can be recognised by its shorter radome and nose-section. This and its digital electronics have made space for a larger 220 kg warhead which increases the overall weight to 630 kg. The semi-armour piercing warhead is believed to contain 80 kg of HE. Electronic improvements give a better Electronic Counter-CounterMeasures (ECCM) performance, as well as simplifying the launch aircraft procedures. Larger booster motors give the missile an increased range of 35 km, as well as allowing the missile to be launched at lower speeds from slower aircraft.



A line diagram of the AS 34 Kormoran 2 missile

Operational status

Kormoran 1 entered service with the German Navy in 1977 and about 350 missiles were delivered. In addition, the Italian Air Force ordered 60 missiles for use with their Tornados. Production ceased in 1983.

Kormoran 2 started development in 1983 and successful firings were completed in October 1990. The missile entered service in 1991 and production is reported to have been completed in 1996 with a total of 140 missiles for the German Navy. In late 1996, some 18 Kormoran missiles were launched in live warhead and telemetry versions, during a multinational naval exercise in the Mediterranean. There are no known exports of Kormoran 2.

Specifications

Kormoran 1
Length: 4.4 m
Body diameter: 0.34 m
Launch weight: 600 kg
Payload: Single warhead
Warhead: 165 kg semi-armour-piercing HE
Guidance: Inertial and active radar
Propulsion: Solid propellant
Range: 30 krn
Accuracy: n/k

Kormoran 2
Length: 4.4 m
Body diameter: 0.34 m
Launch weight: 630 kg
Payload: Single warhead
Warhead: 220 kg semi-armour-piercing HE
Guidance: Inertial and active radar
Propulsion: Solid propellant
Range: 35 km
Accuracy: n/k

Contractors

LFK (part of EADS), Munich, (prime contractor).
Thales, Boulogne-Billancourt, France (radar seeker).

Agni 1/2/3

Type

Short- and intermediate-range, surface-based, solid and liquid propellant, single warhead ballistic missiles.

Development

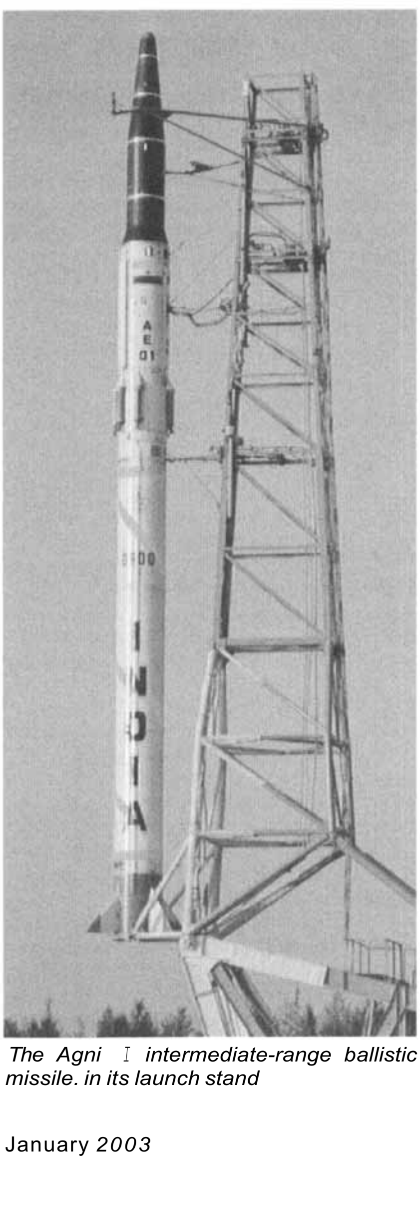
The development for the intermediate-range ballistic missile, called Agni 1 (Fire), started around 1979 under the direction of the Indian Defence Research and Development Organisation (DRDO) at Hyderabad. Agni 1 uses a first-stage motor similar to the first-stage solid rocket motor from the Indian Satellite Launch Vehicle-3 (SLV-3) based upon an earlier US Scout rocket design. SLV-3 has been used in various satellite launches since 1979. The second stage of Agni 1 uses a shortened Prithvi missile liquid-propellant motor system.

There were conflicting reports in 1995 concerning the Agni programme. One report suggested that the programme had been halted due to technical difficulties. The second report suggested that the Indian government was planning a further five test launches. However, in December 1996, the Indian government announced that the Agni 1 trials programme would be terminated, but in July 1997, the development programme was restarted. It seems likely that the programme was restarted as a result of the development of new solid-propellant ballistic missiles in China.

There are believed to be five Agni versions in production or development. Agni Short Range (SR), started in design in 1999, and was tested for the first time in January 2002. This version has a maximum range believed to be 1,200 km, sufficient to target the whole of Pakistan, and has been designed to fill a gap between the Prithvi missiles and Agni 1.

Agni 2 is a new two-stage solid propellant design, with a range of 3,000 km, and the first flight test was made in April 1999. The Agni 2 upgrade version has a range increased to 3,500 km, but has not been flight tested. Agni 3 is a further version, with a range of 5,000 km. This version is believed to be a three-stage solid propellant missile, and will probably be rail mobile. A range of around 4,000 km would be required for a missile to reach Beijing from India. A new first-stage solid motor with a diameter of 1.8 m and carrying 36,000 kg of propellant is being developed, possibly for the Agni 3 missile, which is expected to use the Agni 2 as its second and third stages. An alternative approach would be to use a new third stage for Agni 3, either liquid or solid propellant. An improved optical or radar terminal phase correlation system has been developed to provide greater accuracy. The terminal guidance option could be retrofitted into existing Agni 1 missiles.

There are unconfirmed reports that India is considering the design of an inter-continental range ballistic missile system named Surya, building on the experience of Agni and using the developed Augmented Satellite Launch Vehicle (ASLV) as its basis. Details can be found in the Unclassified Projects section.



The Agni 1 intermediate-range ballistic missile. in its launch stand

Description

Agni SR is a single-stage solid propellant missile using the first-stage motor assembly of the Agni 2 missile. The missile has a length of 14.8 m, a body diameter of 1.3 m, and a launch weight of 12,000 kg. The motor assembly is believed to have a length of 10.8 m. The payload assembly is similar to that developed for Agni 2 but does not have four control fins, separates after boost burn out, has a length of 4.0 m and a base diameter of 0.8 m. It is believed that the payload can be up to 2,000 kg. carrying a 20 kT nuclear warhead or unitary HE, HE submunitions or fuel-air-explosive warheads. The payloads could be reduced to 1,000 kg for maximum range, and could also include penetration aids. The payload assembly is reported to have liquid propellant side thrust motors to provide manoeuvrability to avoid defences, and improved accuracy with a radar correlation terminal seeker operating in C and S band. Agni SR has a maximum range of 860 km, but this could be increased to 1,200 km by reducing the payload. An accuracy of 25 m CEP is estimated at 860 km range. This missile has been described as being road or rail launched, and probably uses adaptations of the Agni 2 launch vehicles.

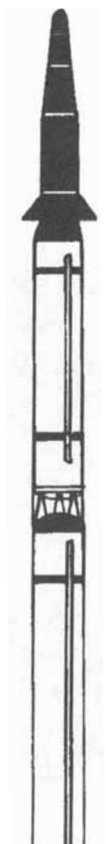
Agni 1 is a two-stage missile, with a length of 21 m, a first stage body diameter of 1.3 m, a second stage body diameter of 0.9 m and an estimated launch weight of 19,000 kg. The first stage is believed to be a version of the first-stage solid-propellant motor used in the SLV-3, with a length of about 13 m and a stage weight around 14,500 kg. This motor is believed to have a burn time of 50 seconds, and a thrust of 45 tons. The second Agni 1 stage is a version of the Prithvi ballistic missile, using the liquid-propellant motor system developed for Prithvi, with a length of 6 m and a weight of 3,500 kg. It is reported that the first test vehicle used in the Agni 1 trials

A mock-up Agni 2 missile displayed in January 2002 on a road TEL (Indian MOD)
NEW/0143185

was smaller, with a total length of 19 m and a launch weight of 14,000 kg, but that the full size missile was used for the second and third test flights. Guidance is inertial, with a twin microprocessor control system, most probably an upgraded version of the system used in Prithvi. The missile is controlled during the boost phase by four moving control fins at the rear, and by secondary injection thrust vector control. It is believed that the warhead section separates to provide a re-entry vehicle on Agni 1, and that the payload is 1,000 kg with a warhead weight of 800 kg. Agni 1 is believed to have a minimum range of 500 km and a maximum range of 2,500 km. The Re-entry Vehicle (RV) is reported to have an attitude control system and aerodynamic manoeuvre fins, presumably to make any defence more difficult. Unconfirmed reports suggest that an optical correlation system was developed for the RV and that the accuracy was around 40 m CEP, although later reports have suggested that the accuracy was 100 m CEP.

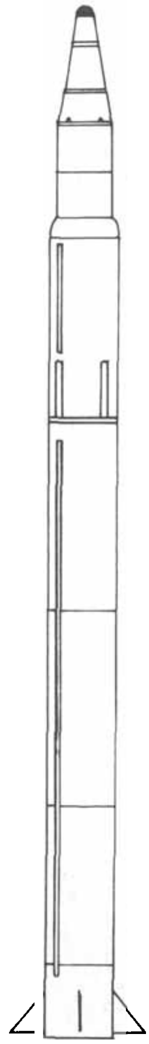
The Indian government initially stated that there were no plans to fit a nuclear warhead to Agni 1, but following the Indian nuclear tests in May 1998, it is assumed that a 45 kT warhead has been developed by the Bhaba Atomic Research Centre. Later unconfirmed reports suggest that an improved 200 kT warhead has been developed, and might be fitted to the Agni 1. It is believed that conventional High Explosive (HE), fuel-air explosive, chemical or HE submunitions warheads might also be developed. A report in 1996 suggested that a submunition warhead containing 500 one kilogram HE submunitions was under development for Agni 1, and possibly for Prithvi SS-150 as well.

Agni 2 has completed development following the first two test launches in April 1999 and January 2001. It has two solid-propellant motor stages, with a payload third stage. The missile has a total length of 20.0 m and a total weight of 16,000 kg. The first stage is similar to that used on SLV-3, but has a length of 10.5 m, a body diameter of 1.3 m and a weight of around 10,800 kg. The first-stage motor burn time is believed to be 50 seconds. The second-stage has a length of 4.8 m, a body diameter of 1.3 m and a weight of 4,200 kg. The motor has a flexible nozzle for control. The second-stage motor burn time is around 60 seconds, although this

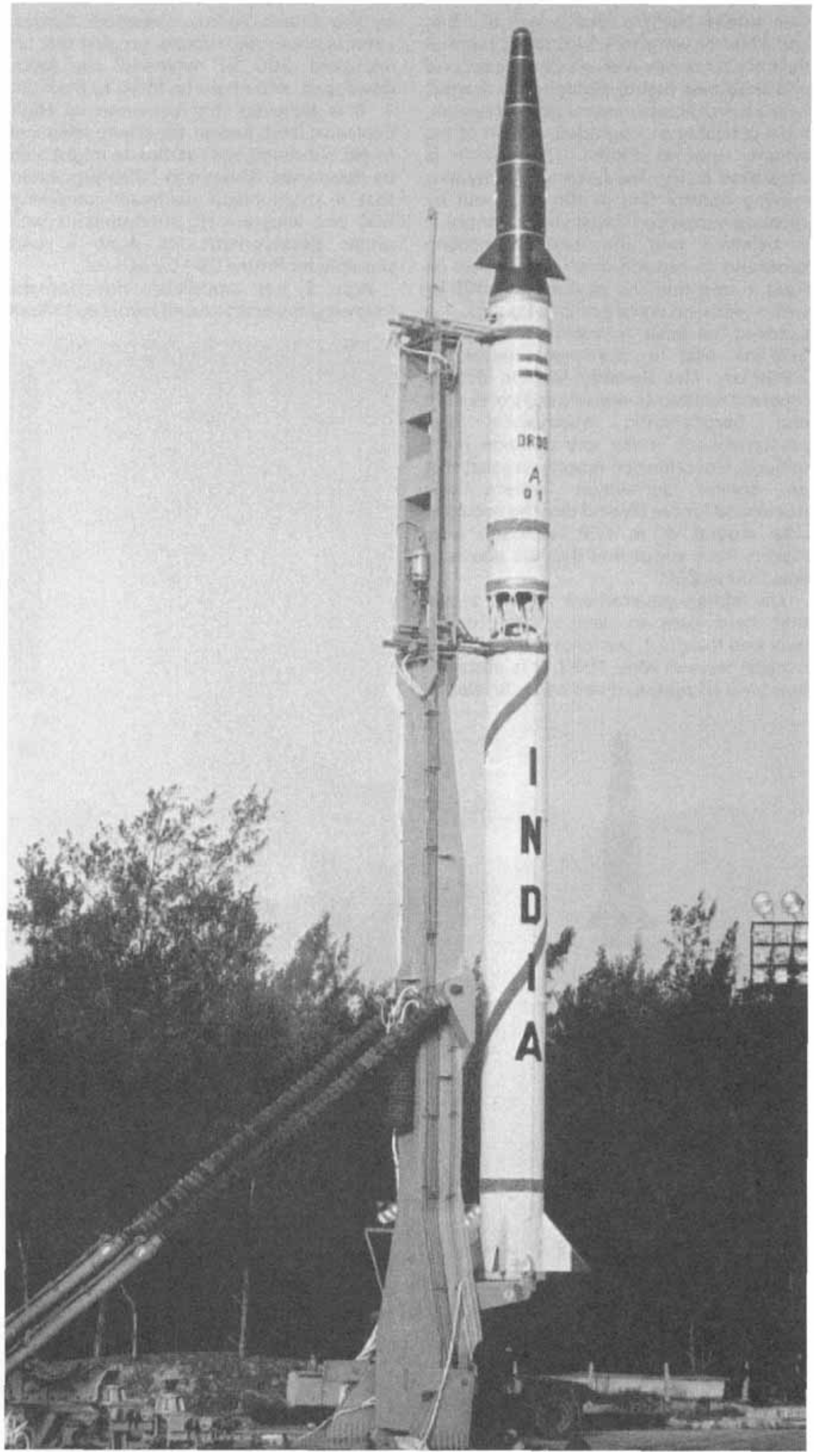


A line diagram of the Agni 2 missile
0089136

An Agni SR missile raised to its launch position from a road TEL (PA)
NEW/0143186



A line diagram of the Agni 1 missile



Agni 2 missile awaiting launch from a railcar *in April 1999* (AP) 0054301

time might include a delay between first-stage burn out and second-stage ignition for certain trajectories. The missile probably has a minimum range of 500 km, with a maximum range of 3,000 km. The payload is believed to be 1,000 kg with a separating 200 kT nuclear warhead that weighs around 700 kg. The payload section has a length of 4.0 m and a body diameter of 0.8 m, and has four moving delta control fins at the rear to manoeuvre during the terminal phase. The RV uses what has been described as an INS/GPS guidance module, with a dual frequency Sand C band radar correlation terminal guidance system. An accuracy of 40 m CEP has been reported. The Agni SR missile tested in January 2002 used a modified **RV** without the four control fins, using a liquid propellant side thrust motor assembly for control, and this might be used in later Agni 2 missiles. Agni 2 was first launched in April 1999, from a converted rail carriage, using a system similar to that used by the Russian SS-24 'Scalpel' missile, with a carriage roof that slides open to allow the missile to be raised to the vertical for launch by two large hydraulic pistons. It is believed that the trains have 4 TEL carriages, a command and control carriage, and a communications carriage. The Agni 2 missile can also be launched from a road TEL vehicle, and that this was used for the second test flight in January 2001. This TEL appears to be a converted tank transporter tractor trailer combination, the tractor has three axles, and the trailer four axles at the rear. It is reported that the missile can be launched from either the rail or road TEL within 15 minutes.

The Agni 2 upgrade version has a maximum range of 3,500 km, which may be achieved by reducing the payload weight, or by upgrading the motors. It is believed that a smaller 20 kT nuclear warhead may be fitted to this missile.

Agni 3 is reported to have a maximum range of 5,000 km. This missile may have both first and second stages as solid-propellant motors similar to those used on Agni 2, with a liquid- or solid-propellant third stage. Alternatively, it is reported that a new solid propellant first stage motor with a diameter of 1.8 m may be used, with the existing Agni 2 stages forming the second and third stages.

Operational status

Development work on Agni 1 is believed to have started in 1979 and the first successful test launch was made in May 1989, when a trials missile flew about 1,000 km. A second test flight was made in May 1992, which failed, due to a fault with the second stage. A third test flight was made in February 1994, with a range reported to be 1,450 km. In 1995, it was reported that a further five flight tests were planned and that a nuclear warhead design had been prepared. The Indian government had described Agni 1 as a technology demonstrator and not a developed weapon system and, in 1996, terminated the programme although making the point that, if a threat appeared, then the Agni 1 design could still be used. It is reported that some 5 to 10 Agni 1 missiles have been built and are held in operational storage.

The Agni programme was restarted in 1997, and, in July 1998 the Indian government announced plans to test two Agni 2 missiles. The first launch of Agni 2 was made in April 1999 from a rail car launcher located on Wheeler's Island, near Orissa in the Bay of Bengal. This flight was over a range of 2,100 km, and is reported to have carried a dummy warhead to test the safety and arming unit in real flight conditions. A second test flight was made in January 2001 from Wheeler's Island, over a range of 2,400 km, and it is believed that this launch was made from a wheeled TEL vehicle. It is believed that low-rate initial production of the Agni 2 version started in May 2001, with an initial order for some 10 to 20 missiles. A small number (less than 5) of Agni 2 missiles are believed to have been operationally available from late 2001, and a production rate of 10 to 12 missiles a year has been suggested. The missiles are reported to be operated by the Indian Army Strategic Rocket Regiment, 555 Missile Group, with 12 TEL vehicles. It is believed that each TEL has around 150 personnel attached.

Agni SR was first flight tested in January 2002, and was launched from a road TEL over a range of 720 km from the Chandipur test centre. The missile was lofted to 300 km apogee. US reports suggest that the RV did not separate as planned, and it is expected that a second test will be made before the end of 2002. The Agni SR missiles are planned to be delivered to the Indian Army Strategic Rocket Regiment, 444 Missile Group, which also operates the short-range Prithvi SS-150 missiles. Agni 3 is in full development and a first test flight is expected by 2003.

Specifications

Agni **SR**
Length: 14.8 m
Body diameter: 1.3 m
Launch weight: 12,000 kg
Payload: Single warhead 2,000 kg
Warhead: 20 kT nuclear, HE unitary, HE submunitions or FAE
Guidance: Inertial with terminal radar correlation
Propulsion: Single-stage solid propellant
Range: 860 km, or 1,200 km (reduced payload)
Accuracy: 25 m CEP

Agni **1**
Length: 21.0 m
Body diameter: 1.3 m (1st stage), 0.9 m (2nd stage)
Launch weight: 19,000 kg
Payload: Single warhead; 1,000 kg
Warhead: 800 kg, nuclear (45 or 200 kT), chemical, HE or submunitions
Guidance: Inertial with optical correlation
Propulsion: Solid propellant 1st-stage; liquid 2nd-stage
Range: 2,500 km
Accuracy: 100 m CEP

Agni 2
Length: 20.0 m
Body diameter: 1.3 m (1st and 2nd stages), 0.8 m payload
Launch weight: 16,000 kg
Payload: Single warhead, 1,000 kg
Warhead: 700 kg, nuclear 200 kT
Guidance: Inertial with GPS and radar correlation
Propulsion: Two-stage solid propellant
Range: 3,000 km (2). 3,500 km (2 upgrade)
Accuracy: 40 m CEP

Contractors

Design and development is being carried out by DRDO, Hyderabad, with production by Bharat Dynamics, Hyderabad. The nuclear warheads are designed and developed by the Bhaba Atomic Research Centre, and the TELs by the DRDO Vehicle research and Development Establishments at Ahmednagar and Puna.

Prithvi (SS-150/-250/-350)(P-1/P-2/P-3) and Dhanush

Type

Short-range, ground- and ship-launched, liquid-propellant, single warhead ballistic missiles.

Development

Reported to have been developed by the Indian Defence Research and Development Organisation (DRDO) in Hyderabad with design work starting in 1983, the Prithvi (Earth) Short-Range Ballistic Missile (SRBM) was first tested in February 1988 The design work may have been with assistance from other countries, and there are unconfirmed reports of European company participation There are two versions of the Prithvi missile, an SS-150, designated P-1, with a range of 150 km and an SS-250. designated P-2, with a range of 250 km The SS-150 missiles are used by the Indian Army, and the SS-250 by the Indian Air Force to attack enemy airfields and by the Indian Army for battlefield support A third version was reported to be in development in 1994, an SS-350. designated P-3, with a range of 350 km, but it is not known if this development has continued

Reports suggest that several nuclear warheads could be fitted to the Prithvi missiles, as well as conventional HE warheads. Unconfirmed reports suggest that an improved liquid-propellant motor is being developed, and that a possible solid-propellant motor is being researched for future Prithvi versions. A ship-launched version, believed to be similar to the SS-250 and named Dhanush, was tested from an offshore patrol vessel in April 2000 It is believed that these missiles might be fitted to future destroyers and frigates A Submarine-Launched Ballistic Missile (SLBM) version of the Dhanush is also being developed by the DRDO, for fitment to the nuclear powered ATV submarines It is also reported that mobile targets may be attacked with Prithvi missiles, using UAVs with TV and Imaging Infra-Red (IIR) sensors to locate these targets Unconfirmed reports suggest that some Prithvi missiles might have a radar scene correlation terminal guidance system, using the small rear fins to control the missile when in the lower atmosphere near the target area. In 1998, it was reported that India will upgrade its Prithvi missiles, starting with the SS-150, to include GPS to improve the accuracy.

Description

It is believed that the Prithvi missile is 8.56 m long and has a body diameter of 1.0 m. The body is made from aluminium alloy and the wings from magnesium. There are four clipped-tip delta wings at mid-body and four small aerodynamic control fins at the rear. It is reported that Prithvi has two side-by-side gimbaled liquid-propellant motors, using IRFNA and a mix of xylidene and triethylamine, enabling a variable total impulse to be programmed for different payload and range requirements. The Prithvi liquid motor and guidance system are reported to have been based upon the Russian SA-2 'Guideline' designs, using S2.720 motors. The missiles can be stored for up to five years, with the liquid propellants.

The SS-150 version, designated P-1, has a launch weight of 4,400 kg and an 800 kg payload. This version has a maximum range of 150 km and a minimum range of 40 km. While confirmed reports state that a High Explosive (HE) pre-fragmented blast unitary warhead has been developed for the SS-150 missile, unconfirmed reports suggest that alternative HE penetration, HE submunitions (incendiary and anti-personnel/anti-armour), fuel-air explosive or chemical warheads may be in development. Following the Indian nuclear tests in May 1998, it is believed that a range of small yield nuclear warheads has been developed, with 1 kT, 5 kT or 12 to 20 kT yields. The small yield nuclear warheads are believed to weigh around 250 kg. A strapdown inertial guidance system is used with twin microprocessors to monitor navigation, as well as providing

A Dhanush missile being launched from the aft deck of a Sukanya class OPV in September 2001 (Indian MOD)

NEW/0143183

A Dhanush missile displayed on a hydraulically stabilised launch platform in January 2002 (Indian MOD)

NEW/0143184

A Sukanya class offshore patrol vessel. used to test launch the first Dhanush missile in April 2000
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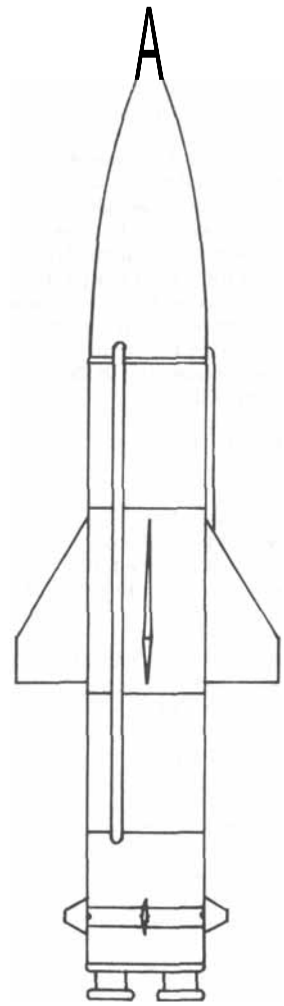
A Prithvi SS-250 missile on its Transporter-Erector-Launcher (TEL) vehicle, on display in February 2001 (Craig Hoyle)
NEW/0109928



A line drawing of the Prithvi missile
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built-in test facilities. Prithvi is believed to have both thrust vector and aerodynamic control and it is reported that the missile climbs to 30 km altitude, then glides to the target area at this altitude, followed by a steep 80° dive onto the selected target. The SS-150 is believed to have an accuracy of 10 m CEP at a range of 70 km, and of 50 m CEP at 150 km, when fired from pre-surveyed sites. Prithvi missiles are carried on a converted Kolos Tatra eight-wheeled Transporter-Erector-Launcher (TEL) vehicle, manufactured by Bharat Earth Movers at Bangalore. A proposed Prithvi SS-150 firing battery would have a command vehicle, four TEL vehicles, four missile reload vehicles, four warhead change vehicles, propellant tankers and four logistics support vehicles. The Prithvi missiles are reported to take 2 hours to set-up and launch, including the time taken to top up the liquid propellants, and to require 18 vehicles to support two missile launches. The support vehicles include a warhead carrier (with 10 warhead canisters), launch control centre, power supplies, safety, oxidiser carrier, fuel carrier, oxidiser transfer, fuel transfer, missile reload, crane, air compressor, and a cable-laying vehicle.

The SS-250 Prithvi missile, designated P-2, is similar in size to the SS-150 version, but has traded a smaller warhead for a longer range, and has a heavier launch weight at 4,600 kg. The payload is believed to be around 500 kg. The minimum range is 40 km and the maximum range has been increased to 250 km. The accuracy is believed to be 50 m CEP, when launched from a pre-surveyed site. This version can manoeuvre up to 15° in the atmosphere, extending the range, and multiple payloads can be dispensed during the flight. There are reports that the SS-250 version will be upgraded to carry the full range of warheads developed for the SS-150, with a payload increased to 800 kg. The Dhanush ship-launched version is believed to be similar to the SS-250. It is expected that two Dhanush missiles will be stored in the helicopter hangar in the ships.

The SS-350 version is believed to have a payload weight of 750 kg and a range of 350 km. Reports suggest that a new liquid-propellant system, or a solid-propellant motor will be used and that GPS guidance will provide an accuracy of around 25 m CEP.

Operational status

First test flown in February 1988, there was a total of 13 test flights completed by 1995. The eleventh launch in June 1993 was reported to have been the first test of the initial production batch, with the result that it is assumed the Prithvi SS-150 effectively entered service in 1994, although there have been conflicting reports as to whether or not these missiles are operational. User trials for the SS-150 version were completed in 1994, including a live HE warhead firing in June 1994. User trials were carried out by the 333rd Indian Army Missile Group at Secunderabad, and it is reported that this Group has continued with training programmes to provide an initial operational capability. The 444 Missile Group was reported to have been formed in May 2002, with a mixture of Prithvi and Agni SR missiles. It is believed that each missile group has 12 operational TEL and three reserve TEL. In 1999 it was reported that a total of 14 development tests and 16 operational evaluation flights had been made. Statements from the Indian government have indicated that the SS-150 missiles remain in storage, but presumably they could become fully operational at short notice. Production of the SS-150 version started in 1993 and is believed to have continued until 1999, with around 60 missiles built and some 35 TEL vehicles. The TEL vehicles can also fire the SS-250 missile version. It is believed that some missiles are stored at Secunderabad, and the remainder at Jullander.

A first reported trial of the SS-250 version was carried out in January 1996, with further tests in 1996, 1997, June 2000, March 2001, and December 2001. It is assumed that this version entered service with the Indian Air Force in 1999, and it is believed that around 70 missiles will be built. The production rate for all Prithvi versions is believed to be between 10 and 30 missiles per year.

The third version, SS-350. is reported to have been first tested in November 1993, from a mobile launch vehicle, but this report may have been incorrect.

Further tests were reported in April 2001, with two missiles launched. It is not clear if this programme has been discontinued, although it is possible that some design work continues as a later upgrade option, probably entering service around 2010.

The ship-launched Dhanush version was first tested from INS Subhadra, a Sukanya class offshore patrol vessel, in April 2000. This test was reported to have failed after about 30 seconds of flight. The ship was anchored in the Bay of Bengal for the test, which was made from a strengthened helicopter deck using a hydraulically stabilised launch platform. A second test was made in December 2000, and a third in September 2001.

Specifications

SS-150
Length: 8.56 m
Body diameter: 1.0 m
Launch weight: 4,400 kg
Payload: Single warhead; 800 kg
Warhead: HE, submunitions, FAE, chemical or nuclear
Guidance: Inertial
Propulsion: Liquid propellant
Range: 150 km
Accuracy: 50 m CEP

SS-250 and Dhanush
Length: 8.56 m
Body diameter: 1.0 m
Launch weight: 4,600 kg
Payload: Single warhead; 500 kg
Warhead: HE, nuclear or submunitions
Guidance: Inertial
Propulsion: Liquid propellant
Range: 250 km
Accuracy: 50 m CEP

Contractors

Bharat Dynamics, Hyderabad (prime contractor).
Hindustan Aeronautics, Bangalore (motors).

A Prithvi SS-250 missile erected in its launch cradle at the rear of the TEL, prior to launch (Craig Hoyle) ***NEW***/0109927

APACHE AP (SCALP EG, Storm Shadow)

Type
Short-range, air-launched, turbojet-propelled, single warhead, air-to-surface missiles.

Development
The *Arme Propulsée A CHarges Ejectables* (APACHE) project was started in 1983 as a joint French/German programme to develop two submunition dispensing systems for carriage by aircraft. Germany withdrew from the programme in 1988, and the development of the missile family was continued by Matra and Aerospatiale (now both MBDA, part of EADS). Flight tests started in 1986, when it was planned to develop an unpowered dispenser plus 50 km and 150 km powered dispensers to attack both fixed and moving targets. By 1991, the programme had focused on a powered 140 km range dispenser, and a proposed cruise missile variant with a range of up to 600 km. The basic APACHE version, known as APACHE AP, carries ten KRISS anti-runway submunitions and has a range of 140 km. A second 140 km range version, known as APACHE AI (or IZ) was proposed for area denial, carrying various mine submunitions. The AI version was also known as APACHE-MAW, and was considered for a German Air Force requirement, but the German programme was cancelled in 1996 and the French project terminated in 1998.

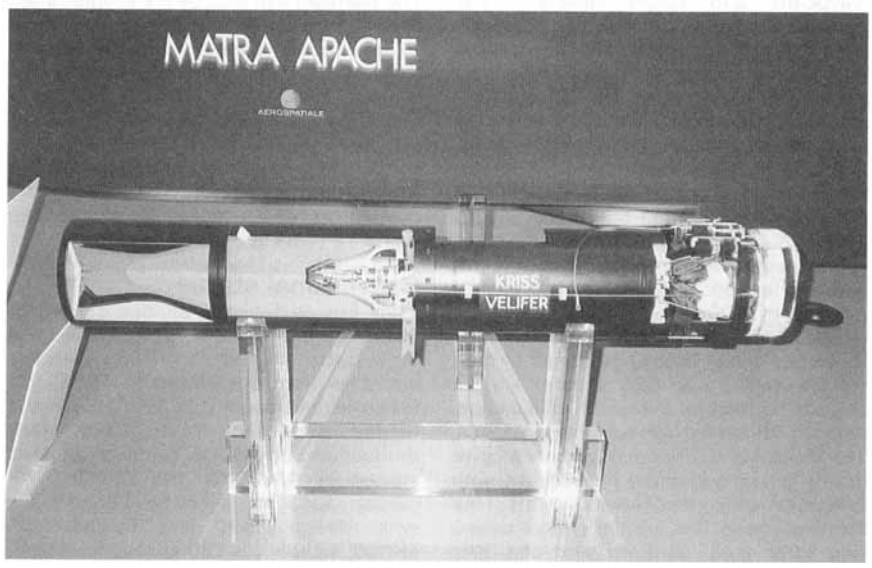
In 1992, the UK was offered a 250 km version of APACHE, which it is believed was based upon a proposal to the French Air Force for a hard target land attack missile with a range varying from 250 to 400 km. In 1993, the basic APACHE design was modified to reduce the radar and infra-red signatures.

In 1994. an *Armement de Precision Tire à Grande Distance* (APTGD) variant of the basic APACHE was proposed for development as a cruise missile with a range varying between 400 and 600 km depending on the payload. However, a version known as the *Systeme de Croisiére conventionale Autonome a Longue Portée* (SCALP EG) was selected by the French Air Force with alternative unitary high explosive or penetrating warheads.

In 1995, an encapsulated version of the APACHE SCALP missile was proposed to the French Navy to be launched from vertical tubes, from a future attack submarine or from surface ships, and also a vehicle-mounted version for use from the land. Also in 1995, BAE (now MBDA) adopted the SCALP EG missile to bid for the UK Ministry of Defence cruise missile programme, but with a modified design called Storm Shadow. Storm Shadow was to be fitted with a unitary general purpose warhead or with a penetrating warhead, and with a range stated as 'over 250 km'. In 1996, it was announced that the SCALP EG and Storm Shadow versions had become virtually identical, with a single penetrator warhead.

In 1996, a further version of SCALP EG/Storm Shadow, called Black Shahine, was offered to the United Arab Emirates for use on their Mirage 2000-9 aircraft. It is reported that this version has a payload of under 500 kg and a maximum range less than 300 km to confirm to the MTCR guidelines. An export order in 1999 from Italy, for the SCALP EG/Storm Shadow version, is believed to involve Italian companies in development and production work sharing agreements.

An APACHE Storm Shadow version in front of a Tornado GR. Mk 1 aircraft (Matra BAe Dynamics) 0003136



A sectioned version of the KRISS anti-runway submunition (Peter Humphris) 0022177

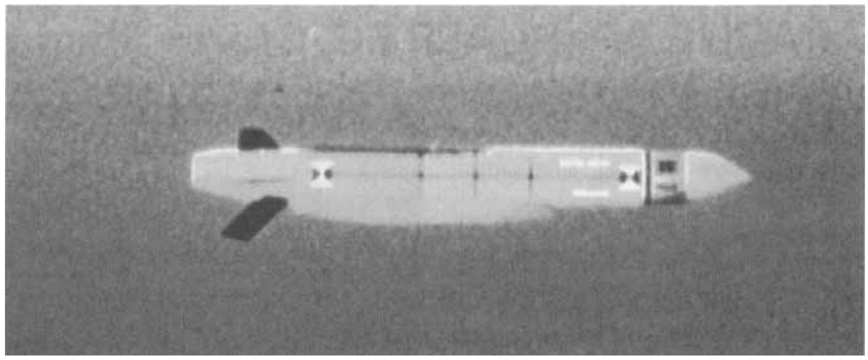
In 2002, a project definition study was awarded to MBDA for SCALP Naval by the French MoD, with the objective to design a ship- and submarine-launched version of SCALP EG. This version would be vertically launched from new Sylver A70 launchers being developed for destroyers and frigates, which would also be able to launch Aster 30, Aster ATBM and Tactical Tomahawk missiles. Submarines would launch the missiles through standard 533 mm torpedo tubes. The new version would have a different airframe with a circular cross-section, new engine, new wings, and a tandem boost motor. SCALP Naval will have a land attack capability, and is expected to have a range of between 400 and 1,000 km when launched from a submarine, and from 600 to 1,400 km when ship launched. Development is planned to start in 2005.

It is expected that APACHE AP missiles will be cleared for carriage on Mirage 2000 and Rafale aircraft, with SCALP EG and Storm Shadow missiles cleared on Mirage 2000, Rafale, Tornado GR Mk 4, Tornado IDS, and Eurofighter Typhoon aircraft.

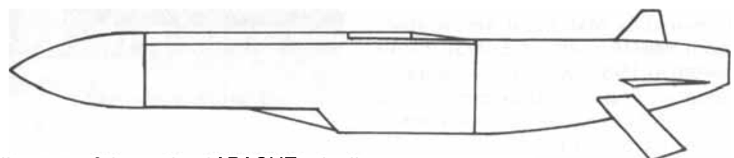
Description
The APACHE AP missile is 5.1 m long, has a rectangular section body with a 0.63 m width and 0.48 m height, has an extended

wingspan of 2.84 m and a launch weight of 1,230 kg. The two wings on the top of the missile body extend after launch, and there are two vertical stabilisers at the rear on both the top and bottom surfaces, with tailplanes on each side. The turbofan engine inlet is underneath the mid-body section, and the missile is powered by a Microturbo TRI-60-30 engine that has a weight of 66 kg. The central 2.2 m body section is available for various submunition payloads up to 560 kg. KRISS submunitions have been developed for APACHE AP, for runway cratering, weighing 52 kg each, and a total of 10 KRISS anti-runway munitions can be carried. The KRISS submunition is cylindrical in shape with flat front and rear ends. The submunition has a shaped charge warhead, a solid propellant motor and a braking parachute. The parachute slows the KRISS and allows the submunition to point vertically down towards the runway; the motor is then fired and the submunition accelerates downwards reaching a speed of 400 m/s in 0.25 seconds. Guidance for the APACHE AP missile in mid-course is inertial and uses navigation waypoints monitored by the terminal guidance radar, which is a Thomson-CSF (now Thales) active MMW radar known as Promethee. The radar will provide radar image correlation for both waypoints and target selection. The maximum range of the APACHE AP missile is 140 km, although this could be increased by exchanging payload for fuel. The missile is believed to cruise at M0.82 at 150 m altitude, descending to 50 m for the terminal phase to avoid defensive systems.

The SCALP EG/Storm Shadow version has a similar shape to the basic APACHE AP, but has a length of 5.3 m and weighs 1,350 kg. SCALP EG/Storm Shadow has slightly larger wings, with a span of 3.0 m when extended. This version will have a payload of 400 kg and a variable range between 250 and 400 km. The Sextant Avionique (now Thales) guidance system will be inertial with GPS updates and an altitude correlation system in mid-course, with an IIR seeker for terminal guidance. The IIR seeker is protected by a nose cover during launch and cruise phase flight, with the cover beingjettisoned at the start of the terminal phase. The inertial system uses a ring laser gyro platform and the BAe Systems developed TERPROM terrain comparison system. The imaging IR seeker is a joint development between Thomson Missile Electronics (now Thales) and Alenia Marconi Systems (now MBDA), and will have autonomous target recognition algorithms to match the terminal scene, identify the target and then select the aim point. This will reduce the aircrew workload, and enable the missile to be carried on single-seat aircraft. The missile will cruise at about M0.8 at 150 m altitude for the mid-course and terminal phases, but then make a pop-up manoeuvre just before impact and dive down at around 45" onto the target. Altitude corrections will be controlled by a Thomson-CNI (now Thales) radio altimeter. The missile will have a two-stage hard target penetrator warhead and fuze system that has been jointly developed by BAE Systems and Thales. This warhead is known as the Bomb Royal Ordnance Augmented Charge (BROACH), having a front shaped-charge that focuses a jet of hot metal to create a hole for the following conventional HE charge. It is reported to be able to penetrate up to 9 m of soil or up to 6 m of reinforced concrete. The warhead can also be pre-programmed to air burst over a target, using its fragmentation effects to damage soft targets such as vehicles, troops and support facilities. SCALP EG/Storm Shadow missiles will be stored in sealed canisters, 5.6 × 1.3 × 1.2 m in size, containing a removable cradle to load the missile onto an aircraft. The missiles are planned to have a stored life of between 8 and 12 years in their canisters.



A trials APACHE missile at CEL in 1995 (Matra BAe Dynamics)



A line diagram of the revised APACHE missile

Operational status

Joint French/German studies started in 1983 for the APACHE programme, and flight tests started in 1986. Germany withdrew from the project in 1988, and full-scale development of APACHE AP was funded by France from 1989. Early production and service qualification trials started in 1995 for the APACHE AP version, and trials flights have been made with Mirage 2000 and Tornado IDS aircraft, including a 120 km overland flight at the Vidsel Test Range in Sweden in October 1996. A total of 14 successful development flight tests have been made with APACHE AP up to January 2002. An export order for APACHE was announced in 1992, with Germany ordering APACHE-MAW anti-runway and area denial missiles for carriage on Tornado IDS aircraft, but this was cancelled in 1996.

In 1994, two development programmes were announced, for the APACHE AI and SCALP EG versions, but the AI version was cancelled in 1998. The SCALP EG version was modified in 1996 to provide commonality with the Storm Shadow version ordered by the UK. Release flights for this version started in 1998, and IIR seeker carriage trials from a Puma helicopter started that same year. The first guided flight test was made in December 2000 from Cazaux in the south of France, with a flight of around 250 km over-land and an attack on a specially constructed target building. BROACH warhead trials started in 1997, and two fully representative missile body and warhead trials against concrete and earth targets were completed in July 1999. A second guided firing was made over the Vidsel test range in Sweden in June 2002, with a flight of over 250 km.

France ordered 100 APACHE AP version missiles in October 1997, and 500 SCALP EG in December 1997. The UK is believed to have ordered around 700 Storm Shadow missiles in February 1997. The APACHE AP version and Storm Shadow are planned to enter service in 2002, and SCALP EG in 2003. Export orders for the Black Shahine version were placed by the United Arab Emirates in 1997, and by Italy in 1999 for around 200 missiles of the SCALP EG/Storm Shadow version. In August 2000 Greece ordered 56 SCALP EG/Storm Shadow missiles.

Specifications

APACHE AP
Length: 5.1 m
Body diameter: 0.63 × 0.48 m
Launch weight: 1,230 kg
Payload: 560 kg
Warhead: HE submunitions
Guidance: Inertial and active radar
Propulsion: Turbojet
Range: 140 km
Accuracy: n/k

SCALP EG/Storm Shadow
Length: 5.3 m
Body diameter: 0.63 × 0.48 m
Launch weight: 1,350 kg
Payload: 400 kg
Warhead: Single HE penetrator
Guidance: Inertial/GPS, TERPROM and IIR
Propulsion: Turbojet
Range: 250-400 km
Accuracy: n/k

Contractors

MBDA, Velizy-Villacoublay, France (prime contractor).

Condor 2

Type
Intermediate-range, road mobile, solid-propellant, single warhead ballistic missile.

Development
Development work started on a project, known as Condor 1, in the late 1970s. to design a space research rocket in Argentina. This programme used both European technologies and European technicians to assist in the development. Condor 1 was exhibited in 1985 at the Paris Air Show as a research rocket and not as a short-range ballistic missile. However, it became apparent that this earlier work was used as the base for the development of a Short-Range Ballistic Missile (SRBM) in Argentina called Alacran, with a range of 150 km.

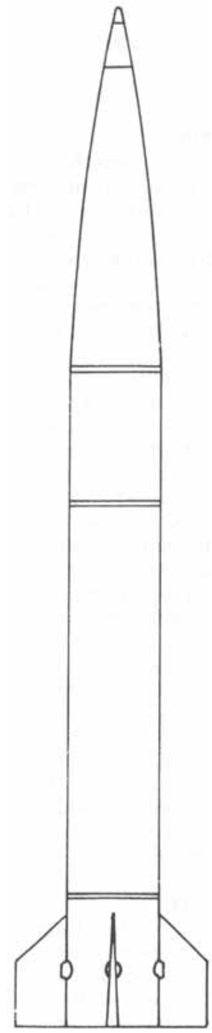
It is believed that, in the early 1980s. design work started on Condor 2, an Intermediate-Range Ballistic Missile (IRBM) but with a range of 900 km. This work relied upon further European technologies. The name 'Condor 2' may have been selected to give the impression that this later research and development programme was associated with a further space research rocket. Reports suggest that Egypt joined with Argentina on Condor 2 around 1984, to assist in development and with an option for later production in Egypt. There was uncertainty over the Egyptian involvement in the Condor 2 programme, and it is believed that the Egyptian Badr 2000 missile project was a cover name for Condor 2. Work in Egypt is believed to have stopped in 1990 and to have stopped in Argentina in 1991. Iraq is also reported to have provided some financial assistance, and there are reports that some development continued for Condor 2 in Iraq until 1991, with solid motor test firings taking place from 1989 onwards, as well as design work for a possible nuclear warhead. A Condor 2 production facility was also being built in Iraq. The Iraqi programme was known as Badr 2000 and several components were destroyed by the UN inspection teams in 1992. An unconfirmed report suggests that early design studies on Condor 3 had started in 1989, with the aim of developing an IRBM with a range of about 1,500 km.

Description
Condor 2 was an IRBM with a length of about 10.5 m, a base body diameter of 0.8 m and a launch weight believed to be 5,200 kg. The two-stage missile was reported to have a solid propellant first stage, a liquid propellant second stage and a range of about 900 km. The payload is thought to have been around 450 kg, with conventional High Explosive (HE), nuclear or chemical warhead options including a suggested fuel-air explosive warhead. Guidance was to be inertial, but it is difficult to assess the accuracy of Condor 2 without knowing more about the control systems that were to be used. A diagram depicted Condor 2 as having four control fins at the base, but this may have been a view of the research rocket Condor 1. The missile was reported to be road mobile, with a transporter-erector-launcher vehicle being developed specifically for this programme.

Operational status
Condor 2 was in early development when the programme reportedly ceased in 1990, but the precise status remains unknown, and there has only been a single reported test flight in 1989 over a range of 500 km. The missile programme was believed to be a collaborative project involving Argentina, Egypt and Iraq, with missiles or components to be produced in all three countries, with another unconfirmed report suggesting possible assembly in Romania as well. An unconfirmed report from the USA suggested that Egypt left the Condor programme in 1989 and it is believed that the Iraqi research facilities were destroyed, both in the 1991 Gulf War and later by the UN inspection teams. Argentina decided to discontinue the missile development and this was formally announced by the government in May 1991, although it is possible that Argentina might at some future stage continue with Condor 2 solely as a satellite launch vehicle.

Reports in 1991 suggested that up to 30 missile assembly sets were complete in Argentina, lacking only guidance components. The precise status of the Condor 2 programme in both Argentina and Iraq remains unresolved. A report in 1992 suggested that Argentina offered Condor 2 technology to Spain, to help with the development of a satellite launch vehicle known as Capricornio.

A report in 1995 suggested that Iraqi technicians were working in Libya on a revival of the Condor 2 programme, but this remains unconfirmed. The report could have been referring to Iraqi technicians assisting with the delayed Libyan Al Fatah project or even working in Libya on a future Iraqi ballistic missile programme to avoid the UN inspection teams operating in Iraq.



A line diagram of the Condor 2 missile
0038247

Specifications
Length: 10.5 m
Body diameter: 0.8 m
Launch weight: 5,200 kg
Payload: Single warhead; 450 kg
Warhead: Conventional HE, chemical or nuclear
Guidance: Inertial
Propulsion: 2-stage, solid (1st) and liquid (2nd)
Range: 900 km
Accuracy: n/k

Contractor
Not known.

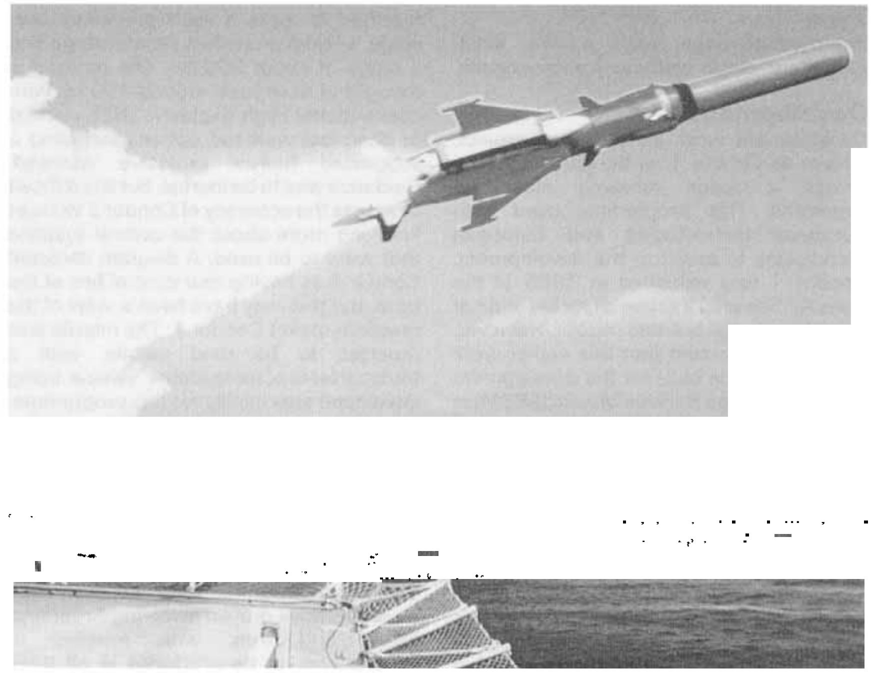
MILAS

Type

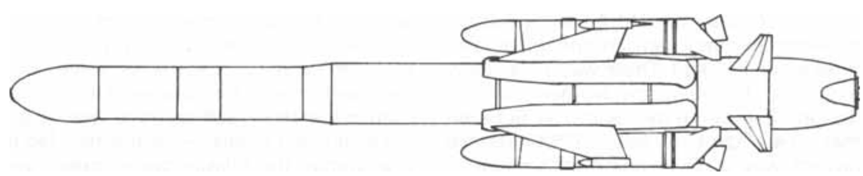
Short-range, ship-launched, turbojet-powered, single warhead anti-submarine missile.

Development

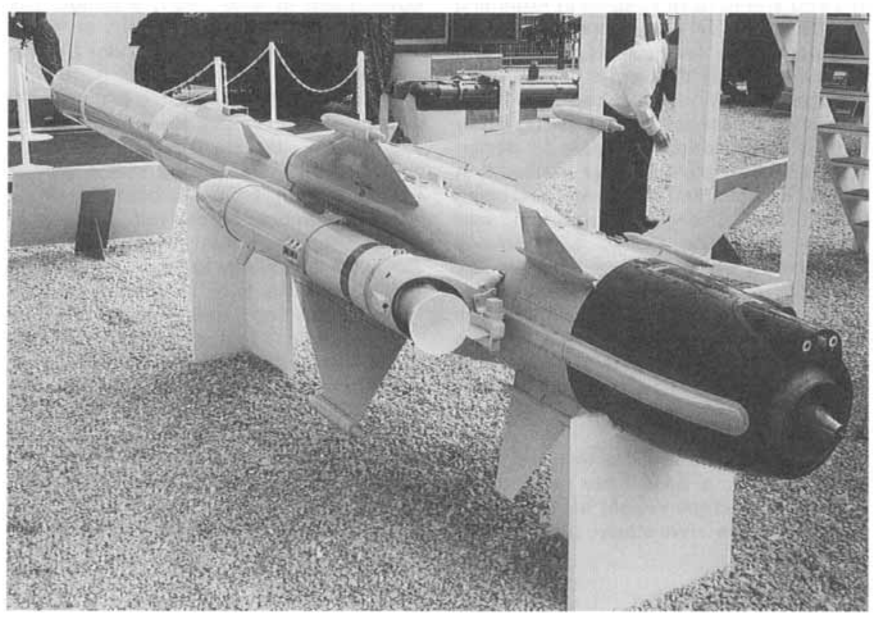
MILAS (***Missile de Lutte Anti-Sous-marine***) was first revealed in 1986, and has been developed to a joint French and Italian navy requirement for an Anti-Submarine Warfare (ASW) torpedo delivery system. The requirement was to defend ships against enemy submarines, by using VLF active and passive sonars for surveillance and tracking, and to launch the MILAS torpedo carrier at sufficient range to deny the submarines the chance to use their torpedoes. The French had decided to upgrade the Malafon system and proposed using the jointly developed Otomat missile as the carrier vehicle for the torpedo and, in 1986, the Italian government agreed to join the programme. A joint company, GIE Milas. was formed by Alenia (now MBDA, part of EADS) and Matra (now MBDA) to lead the development and production teams. MILAS can be launched and controlled by the Otomat or Teseo Mk 3 weapon control systems on board ships, with mixed loads on both four and eight missile launch assemblies enabling the combined weapon control system to control up to 12 missiles. The Italian Navy decided in November 2000 to fit MILAS to the two 'De La Penne' class destroyers, with four launchers each.



***A development flight test launch of a** MILAS **missile (Matra** BAe Dynamics)* 0089925



A line diagram of the MILAS missile



A rear view of a MILAS missile. taken at Paris in 1995, showing one of the two solid-propellant boost motors attached to the side of the missile (Duncan Lennox)

Description

MILAS uses the basic Otomat Compact missile, but replaces the warhead and terminal seeker sections with a torpedo. The missile has four folding delta-shaped wings at mid-body with command receivers fitted at the tips and four small clipped triangular moving control fins at the rear. The missile is 6.0 m long and has a body diameter of 0.46 m. The launch weight, including two 75 kg jettisonable boost motors, is around 800 kg. MILAS will use a joint French/Italian torpedo, called MU 90 Impact, which is an amalgamation of the earlier MU 90 and A290 French and Italian torpedo programmes. The MU 90 Impact torpedo has a length of 3.0 m, a diameter of 0.324 m, and a weight of 300 kg. It has a 59 kg HE shaped charge warhead, acoustic guidance, electric propulsion and a range of 10 km. This torpedo is reported to have a speed of 55 kt. Design studies have examined the use of other lightweight torpedoes, such as the US Mk 46, UK Sting Ray and Italian A 244/S. MILAS is mounted in a sealed container which is used for storage, transportation and launching the missile. Target co-ordinates are pre-programmed into the MILAS inertial navigation unit before launch, with provision for several mid-course updates to be passed by datalink from either the launching vessel or an aircraft/helicopter. In the terminal phase the turbojet engine of the missile is shut down, the torpedo separates from the missile and descends by parachute until it enters the water. After water entry the torpedo uses its own sonar to actively home on to the target submarine. The MILAS turbojet engine has a thrust of 400 kg, which gives the missile a cruising speed around M0.9. The minimum range is 5 km and the maximum range around 60 km. It can reach 35 km in under 3 minutes from launch.

Operational status

Development of MILAS started in the early 1980s and the system was expected to enter service with the French and Italian navies in 2000. The first trials test firings were made in 1989 and the first sea firing was carried out from an experimental ship in April 1994. By September 1998 a total

of four development firings had been made, with the fourth test using an MU 90 torpedo, and this completed the joint development programme. In April 1998, the French government announced that MILAS funding would be terminated at the end of 1998, but it is reported that the Italian Navy placed a production order in *2000.* Initial production deliveries are planned for 2002/2003. Over 1,000 MU 90 torpedoes have been ordered by France, Italy, Germany, Denmark and Chile, and it is expected that export orders for MILAS might be made from some of these countries.

Specifications

Length: 6.0 m
Body diameter: 0.46 m
Launch weight: 800 kg
Payload: Single MU 90 torpedo, *300* kg
Warhead: HE 59 kg
Guidance: Inertial with command updates
Propulsion: Turbojet
Range: 60 km
Accuracy: n/k

Contractors

Eurotorp GIE, Sophia Antipolis, France (MU 90 torpedo).
MBDA, Rome, Italy.
MBDA, Velizy-Villacoublay, France.

Otomat/Teseo

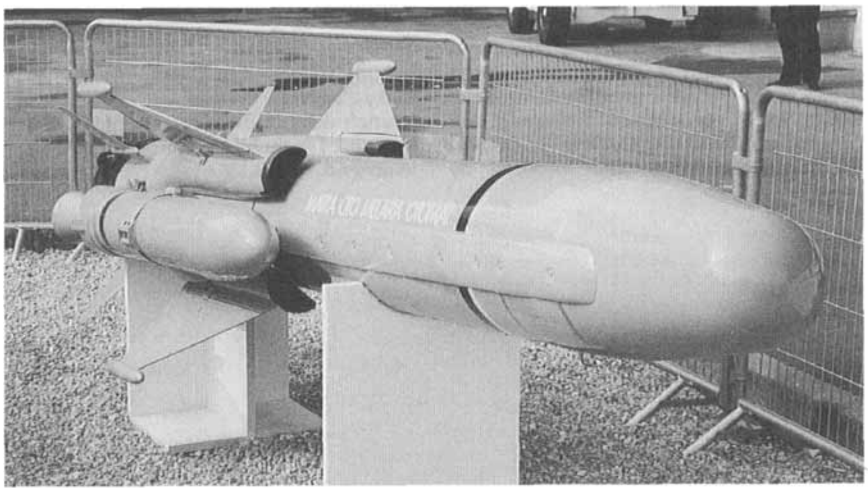
Type

Short-range, ship- and ground-launched. turbojet-powered, single warhead, surface-to-surface missiles.

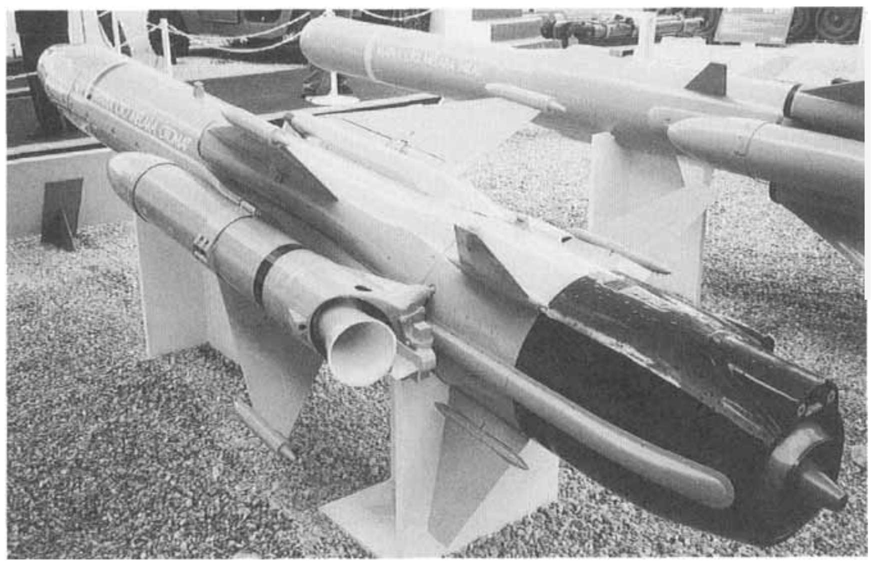
Development

The Otomat anti-ship missile was developed as a private venture by Otobreda (now MBDA, part of EADS) with Matra (now MBDA) from 1969. Firing trials began in 1971, with the first complete system test in 1972, and the first production missile was accepted in 1976 by the Italian Navy. Development of an extended range version, Mk 2, began in the early 1980s, with final qualification tests in November 1983. From this, the French developed a lightweight version, Otomat Compact, with a new launcher-container. Coastal defence versions have also been produced and Otomat will be the basis for the French-Italian 'MIssile de Lutte Anti-Sous-marine' Anti-Submarine Warfare (MILAS ASW) torpedo delivery system. In the Italian Navy the missile control system is known as Teseo, and sometimes the Otomat Mk 2 is referred to as the Teseo 2 system. An Otomat Mk 3 development programme was started in 1994, with an improved dual-mode IIR/active radar seeker and a programmed guidance system. Different approaches were taken with Otomat Mk 3, the Italian version had an increased range capability to 300 km and this version was separately marketed as Teseo 3. Discussions were held in 1995 between the Italian and US navies and it was reported that a modified Teseo 3, called Ulisee (or Ulixes), might have been jointly developed, but the US interest did not materialise. Ulisee would have improved stealth and mid-course updates and was planned for a ship, ground or air launch. This version would also have an increased speed, to M0.95, for the terminal phase. In 1998, it was reported that Italy and Sweden might co-operate on the Teseo 3 (or Ulisee) programme, but by 1999 Italy was proceeding alone. A Next Generation Anti-Surface Missile (NGASM) proposal was made to the Italian MoD in 2001, as a replacement for the Teseo 3 project. This version would have a range of 200 to 250 km. A dual-mode IIR and X-band active radar seeker development programme was funded in 1999, and this radar is to have a ground mapping capability. A datalink development was started in 2001. A block 3 upgrade to Otomat Mk 2 has been developed, introducing insensitive boost motors and warheads. A block4 upgrade is planned for development with reduced volume electronics, more fuel, GPS guidance and a new signal processor for littoral warfare and land attack. The block 4 upgrade will also include an upgraded digital weapon control system. It is expected that the Otomat Mk 2 block 4 and the NGASM programmes will be co-ordinated.

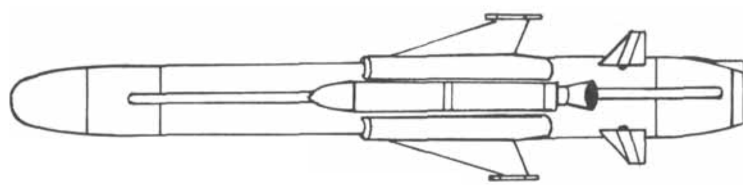
The Otomat missile is fitted to the Italian light aircraft carrier *Giuseppe Garibaldi* and the cruiser *Vittorio Veneto,* in four-launch canisters; destroyers of the 'De La Penne' and 'Audace' class, with eight missiles in four twin launchers; frigates of the 'Maestrale' and 'Lupo' classes with four and eight missiles respectively; and corvettes of the 'Minerva' class are fitted for, but not with, four missile launch canisters. Otomat is fitted to 'Madina' class F2000 frigates belonging to the Royal Saudi Navy, with an eight missile system. Both Otomat Mk 2 and the MILAS anti-submarine missiles are planned to be launched from the same launchers and use the same weapons consoles, with up to 12 Otomat and MILAS missiles being controlled by the same weapons system.



The Otomat Mk 2 missile, showing the turbojet engine intakes at the wingroots. and one of the jettisonable solid-propellant boost motors (Duncan Lennox)



A rear view of an Otomat Mk 2 missile. showing the jettisonable solid-propellant booster and command update receive antenna (Peter Humphris)



A line diagram of the Otomat Mk 2 missile

Description

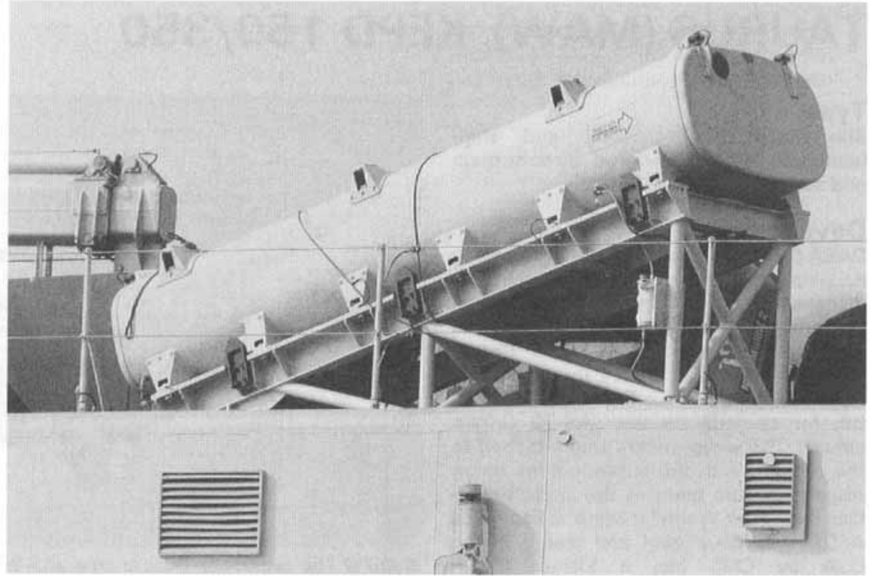
Otomat has a cylindrical body with a blunt nose and a belled exhaust nozzle at the tail. There are four delta-shaped wings at mid-body with command receivers fitted to the wingtips and four small clipped triangular moving control fins at the rear. The wings are fixed on the Mk 1 but folded on the Mk 2. The missile is 4.46 m long and has a body diameter of 0.46 m at its widest point. The launch weight is 770 kg, with two jettisonable 75 kg booster motors and a 210 kg warhead. Otomat is mounted in a sealed container, which is used for storage,

transport and launch. The container is fitted to deck mountings or a coastal battery truck body and the containers are pre-aligned at the correct launch angle (15°). Target co-ordinates can be obtained from the launch platform sensors, limiting the range to about 60 km. and this is the system operation for Otomat Mk 1. For Otomat Mk 2 the system range was extended by using either other ships, aircraft or helicopters for over-the-horizon targeting, giving an increased range of up to 180 km. At launch the weapon climbs to an initial height of 250 m at a distance of about 600m from the launcher. The autopilot/altimeter system then commands it to descend to its cruising altitude of 20 m for the mid-course phase. During this phase the guidance system can receive command updates on the target position. At a predetermined point from the target, the azimuth-only active radar seeker is activated in 20° left/right azimuth scan search mode. When the target is found and the radar seeker locks on, the missile is commanded to descend to its final attack sea-skimming mode. However, the full range of 180 km for Otomat Mk 2 can only be achieved with over-the-horizon targeting assistance, otherwise the range is limited to 80 km.

In the case of the French supplied missile (also used in the coastal variant), the seeker operates in azimuth and elevation; at seeker lock-on the missile is commanded to climb to about 2,000 m in order to attack in a 7" dive. Propulsion for the boost phase is provided by two 75 kg weight, jettisonable, 3,500 kg thrust, four-second burn, solid-propellant motors mounted on either side of the missile body. The sustainer motor is a Turbomeca TR281 400 kg thrust turbojet, which gives the missile a cruise speed of about M0.9. The Extended Range Targeting of Otomat (ERATO) mounted on board 'Madina' frigates of the Royal Saudi Navy, has the capability to launch missiles at three second intervals and to control up to eight missiles in flight simultaneously to six different ship targets.

The Italian version, Teseo 3, (or Ulisee/Ulixes) had an increased weight to 800 kg and an increased range of 250 km. Teseo 3 had a dual-mode active radar/imaging IR seeker and could be used against both ship and land targets. The missile was 5.6 m long and had a lighter HE SAP warhead at 160 kg. It is reported that an INS/GPS guidance unit and a digital datalink have been added, so that target designation may be updated from a separate aircraft or helicopter.

A combined Otomat Mk 2 and MILAS ship- or ground-based weapons control system has been developed, to enable the mission planning and firing of combinations of the anti-ship and anti-submarine missiles. Most ships can carry up to 12 missiles, and these can be launched from canisters oriented as required to clear obstructions, as both missiles can change course after launch by up to 210".



*An Otomat Mk 2 missile ship **launcher** assembly* (Harry Steele) 0022176

While most Otomat missiles are mounted on ships, a series of C-13 tracked vehicles has been proposed for the ground-launched coastal defence Otomat system. The tracked vehicles would include a two missile launch vehicle, a surveillance/engagement radar on a command and control vehicle and a datalink vehicle. An additional surveillance radar could be located on high ground or mounted on a light aircraft or helicopter to increase the Otomat system range.

Operational status

Otomat Mk 1 entered service in 1976 and the Mk 2 version in 1984. The Mk 2 version is still in production, and a total of 1,080 Mk 1 and Mk 2 missiles has been built or are on order for fitting to 100 ships. A Mk 3 version was in development, but is believed to have been terminated in 1999. The alternative longer range Teseo 3 (Ulisee/Ulixes) was expected to be available by 2003, but is believed to have been changed to the NGASM programme, which is expected to start development in 2005. The prime Otomat missile user is Italy, with export sales to Bangladesh, Egypt, Iraq, Kenya, Libya, Malaysia, Morocco, Nigeria, Peru, Saudi Arabia and Venezuela. The Otomat coastal defence system is in service with Egypt and Saudi Arabia. Malaysia ordered Otomat Mk 2 block 3 missiles in 1997, and the first missile was tested in June 2000. The block 4 version might be combined with the NGASM programme at some future date.

Specifications

Otomat Mk 1
Length: 4.46 m
Body diameter: 0.46 m
Launch weight: 770 kg
Payload: Single warhead 210 kg
Warhead: HE semi-armour-piercing
Guidance: Inertial, command update and active radar
Propulsion: Turbojet
Range: 60 km
Accuracy: n/k

Otomat Mk 2
Length: 4.46 m
Body diameter: 0.46 m
Launch weight: 770 kg
Payload: Single warhead 210 kg
Warhead: HE semi-armour-piercing
Guidance: Inertial, command update and active radar
Propulsion: Turbojet
Range: 180 km
Accuracy: n/k

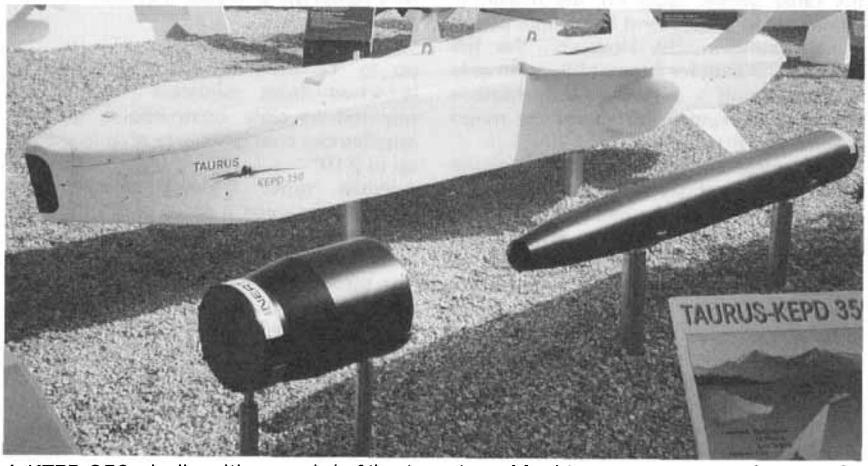
Teseo Mk 3 or NGASM
Length: 5.6 m
Body diameter: 0.46 m
Launch weight: 800 kg
Payload: Single warhead 160 kg
Warhead: HE semi-armour piercing
Guidance: Inertial with GPS and updates, and active radar with IIR
Propulsion: Turbojet
Range: 250 km
Accuracy: n/k

Contractors

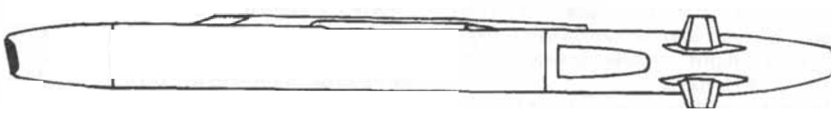
MBDA, Rome, Italy.
MBDA, Velizy-Villacoublay, France.

TAURUS (MAW), KEPD 150/350

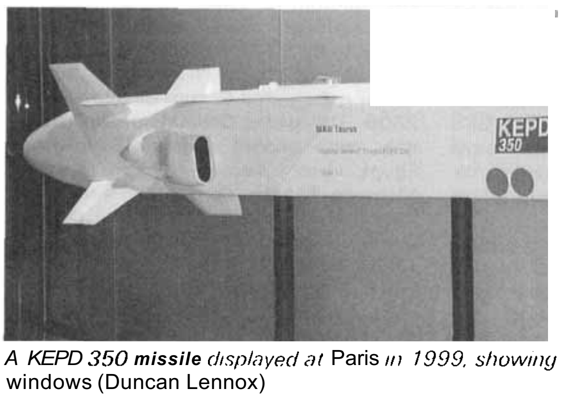
A KEPD 150 evaluation missile on a *JAS-39 Gripen* fighter (DASA/FMV) 0089924



A KEPD 350 missile with *a* model of the two-stage *Mephisto penetrator warhead in the* front (Peter Humphris) 0054296



Line diagram of the *KEPD 350* missile 0054295



A KEPD 350 **missile** *displayed at* Paris *in 1999, showing the engine air intakes* and *fuze* windows (Duncan Lennox) 0089923

Type

Short-range, air-, ground-, and ship-launched, turbojet powered, air-to-surface and surface-to-surface missiles.

Development

DASA (LFK, now part of EADS) in Germany developed a family of aircraft submunition dispensers in the late 1980s. called Dispenser Weapon System (DWS) 24. This was adapted, from 1985, with Bofors Missiles (now Saab Bofors Dynamics) for the Royal Swedish Air Force as the DWS 39, for carriage on the JAS-39 Gripen aircraft. These dispensers stay attached to the aircraft, with the submunitions being dispensed from them as the aircraft overflies the target. A similar system, known as AFDS, was developed and tested in the USA by CMS Inc, a former DASA subsidiary, and by LFK in Germany where it was known as MW 2. In 1995 a powered version of DWS 39 was proposed by LFK and Bofors Missiles. This Kinetic Energy Penetrator and Destroyer (KEPD) 350 missile was fitted with a Mephisto 450 kg dual-charge kinetic energy penetrator warhead, and has a range of 350 km. This version is now known as MAW Taurus KEPD 350. Two further powered variants were added in 1996, a lighter KEPD 150 with a range of 150 km and a MAW/PDWS 2000 missile with a range of 100 km. A ship-launched version of the KEPD 150 missile was proposed in 1997, designated KEPD 150-SLM, and a powered version of the AFDS dispenser, known as AFDS-T, was proposed by CMS with a range of 250 km.

In 1998 the MAW/PDWS 2000 version was replaced by two proposals, called Taurus 350A and Taurus 350P. The Taurus 350A carries submunitions to a range of 200 km, while the Taurus 350P has the Mephisto penetrator warhead and a range of 300 km. Following a development contract from the German MoD in March 1998, a joint company was formed in Germany by DASA (LFK, part of EADS) and Celsius (now Saab Bofors Dynamics), called Taurus Systems GmbH. Negotiations were reported with Alenia Marconi Systems (now MBDA. part of EADS) and CASA (part of EADS) in 1999 for possible future participation in Taurus Systems, but it *is* believed that no agreement was reached.

It is planned that the MAW Taurus KEPD 350 missiles will be carried on German Tornado and Eurofighter Typhoon aircraft, and the KEPD 150 on Swedish JAS-39 Gripen aircraft. The KEPD 150-SLM has been proposed for German Navy frigates and corvettes. Australia ordered some KEPD 350 missiles in 1999, and these will probably be fitted to their F/A-18 Hornet aircraft.

Description

The KEPD missiles have a rectangular shaped body with **two** folding wings fitted to the upper surface and four tail fins inclined at 45°. There are two side mounted engine air inlets and the turbojet engine exhaust is located in the boat tail section. The mid-course guidance is provided by a TriTec combined INS/GPS system with terrain navigation updates (ternav) at selected waypoints on the planned route using the imaging IR seeker, with a radar altimeter to enable low-level cruise altitudes down to 50 m to be achieved. The missiles are fitted with an imaging IR seeker for terminal guidance. The imaging IR seeker has been developed by LFK for the Polyphem fibre-optic guided missile system and upgraded by BGT. This seeker uses an indium antimonide focal plane array, operating in the 3 to 5 micron band. A Williams WJ 38-15 turbojet has been selected to power the missiles, and

Specifications

	KEPD 150	KEPD 150-SLM	KEPD 350	Taurus 350A/P
Length:	4.6 m	5.6 m	5.1 m	5.1 m
Body diameter:	0.63/0.32 m	0.63/0.32 m	0.63/0.32 m	0.63/0.32 m
Launch weight:	1,060 kg	1,160 kg	1,400 kg	1.090 kg(A)/1,240 kg (P)
Payload:	Single warhead	Single warhead	Single warhead	Submunitions (A), Single warhead (P)
Warhead:	450 kg KEP	450 kg KEP	450 kg KEP	450 kg
Guidance:	INS/GPS, ternav and IIR	INS/GPS, ternav and active radar	INS/GPS, ternav and IIR	INS/GPS, ternav and IIR
Propulsion:	Turbojet	Solid propellant and Turbojet	Turbojet	Turbojet
Range:	150 km	270 km	350 km	200 km (A), 300 km (P)
Accuracy:	n/k	n/k	n/k	n/k

the missiles are expected to have a cruise speed of around M0.9. The fuel tanks are located around the warhead bay.

The KEPD 150 missile has a length of 4.6 m, a body width of 0.63 m, a height of 0.32 m, a wing span of 1.0 m and a launch weight of 1,060 kg. The maximum range of the KEPD 150 missile is 150 km. The warhead for the KEPD 150 and KEPD 350 missiles will be the Mephisto dual-charge penetrating warhead, which has a weight of 450 kg. The front precursor charge has an electro-optic fuze, and forges a hole in the outside of the structure being attacked, through which the main penetrator warhead is boosted at a speed of 250 m/s. The main warhead assembly has a Programmable Intelligent Multi-Purpose Fuze (PIMPF) fitted at the rear, that can count the floors and voids penetrated and detonate the HE charge at the pre-selected depth within the hardened structure or building. The Mephisto warhead can also be air-burst for blast fragmentation effect against a soft target. The missile can be programmed to make either a shallow or a steep dive onto the target.

The KEPD 150-SLM ground- or ship-launched version will have an additional solid-propellant boost motor mounted in tandem behind the turbojet engine, and jettisoned after use. Present proposals are that this missile will have an active radar terminal seeker, an improved version of the Thomson-CSF (now Thales) radar in the AS 34 Kormoran 2 missile. Later models of the KEPD 150-SLM may have a dual-mode seeker, using active radar and imaging IR. This version will have a length of 5.6 m, including the boost motor assembly. It is believed that this missile will have a launch weight of 1,160 kg when fitted with a Mephisto warhead. The missiles will be launched from a canister with a length of 6.0 m, with a total weight of just under 2,000 kg including the missile, in two or four canister assemblies. The maximum range is 270 km.

MAW Taurus KEPD 350 has a length of 5.1 m, and will carry more fuel with an increased launch weight of 1,400 kg and a maximum range of 350 krn. This version will be fitted with the Mephisto warhead and will be similar to the KPED 150.

Taurus 350A/P are the latest proposals for further missiles, the 350A will carry submunitions to a range of 200 km and the 350P will carry the Mephisto penetrator warhead for a maximum range of 300 km. 350P will have a launch weight of 1,240 kg. Both versions will have a length of 5.1 m. 350A will have a launch weight of 1,090 kg and will probably use the radar altimeter to dispense the submunitions at the correct height. It is expected that the payload of this version will be interchangeable with the fuel load, *so* that a variety of submunitions can be carried to different ranges. The reported submunitions planned for 350A are the MUSJAS 1/2, STABO and SMArt-SEAD. The MUSJAS submunition is used against lightly armoured targets, and produces explosively formed fragments. STABO is an anti-runway submunition, with a tandem HE warhead and a weight of 16 kg. The SMArt-SEAD submunition has been developed from a 155 mm artillery shell submunition, and has MMW active and passive radars and an IR sensor to locate armoured vehicles, and to attack them with an explosively formed warhead that penetrates the top armour.

A Taurus Communications Centre (TCC) has been developed by Base Ten Systems for mission planning for all versions of the missiles, and this will be connected to the German Air Force command and control information system.

Operational status

The prototype MAW Taurus KEPD 350 missile was first test flown in August 1996, on a German Tornado, and a captive carriage flight of the KEPD 150 was first made on a Swedish JAS-39 Gripen in August 1998. A three and a half-year development contract was placed in March 1998 by the German MoD for the KEPD 350 version, which includes for 28 test and evaluation missiles. A first flight using six navigation waypoints was made in northern Sweden in October 1999, but without a terminal seeker. A second test flight was made in Sweden in September 2000, with a terminal seeker. Captive carry tests were made at the Overberg range in South Africa in November 2001, and these were followed with a second guided flight over a range of 350 km in April 2002. This last flight test used the TCC mission planning system. It is expected that some 600 missiles will be required by the German Air Force, with an in-service date of 2004. The German Navy are evaluating a proposal for a ship-launched version of the lighter KEPD 150 missile (KEPD 150-SLM) and the Royal Swedish Air Force are undertaking project definition studies for the KEPD 150 for use on the JAS-39 Gripen. Australia ordered some KEPD 350 and 350A missiles in 1999.

Contractor

Taurus Systems GmbH, Schrobenhausen, Germany.

Shahab 3/4

Type

Intermediate-range, road mobile, liquid-propellant, single warhead ballistic missiles.

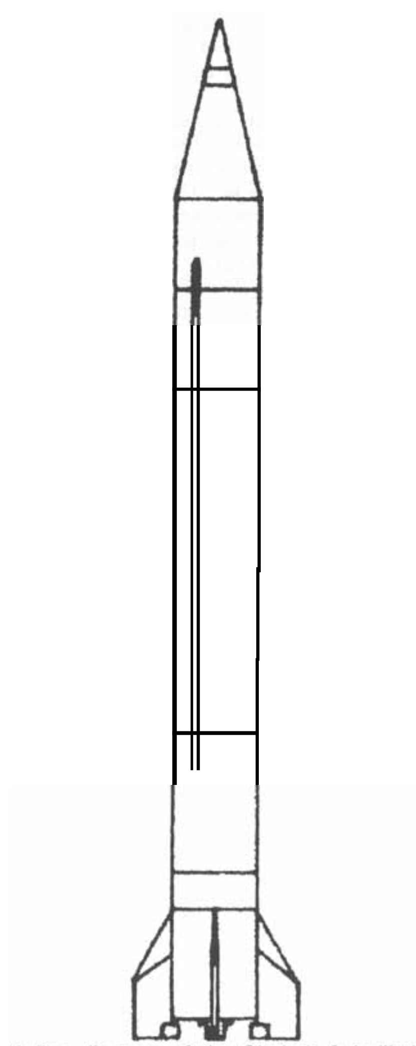
Development

There have been reports from Iran since 1986, of the development of a new intermediate-range ballistic missile and the programme has been given various names including Shahab 3, Shihab 3, Shehob 3 or Zelzal 3. In 1993, it is believed that Iran and North Korea agreed on the joint development of the North Korean No-dong 1 and No-dong 2 single-stage liquid-propellant missiles, and that Pakistan probably joined the programme (for the Ghauri 1/2 missiles) at the same time. The No-dong design was based on the Russian 'Scud B' technologies, following the manufacture of 'Scud B' and 'Scud C variant missiles in North Korea and their subsequent sale to Iran. No-dong and Shahab 3 both appear to be based on a scaled-up design of the 'Scud B' or 'Scud C', probably similar to the former Soviet Union's R-5 missile *SS-3* 'Shyster'. It was reported that Iran would purchase and manufacture a total of 150 No-dong missiles, with full range trials carried out in Iran, because North Korea had difficulty in conducting such trials without overflying Japanese territory. Pressure from several countries in 1994 is reported to have led to North Korea abandoning the Iranian programme. Reports in 1997 suggested that Iran was conducting a series of seven motor tests for a missile programme, and that the missile was called Shahab 3. It is believed that North Korea delivered a small number, probably 5 to 12 missile assemblies, to Iran from 1994 onwards, with four TEL vehicles and that these deliveries stopped and were then restarted in 1997.

Further deliveries, up to a total of 20 missile sets, are believed to have continued up to 2002. It is reported that the Shahab 3 development is led by the Aerospace Industries Authority, and that the final assembly and test is being carried out by Hermat Missile Industries in Tehran, with the missile motors and fuel tanks made in a large underground facility at Khojan. A flight test by Pakistan in April 1998, for its intermediate range ballistic missile programme called Hatf 5 or Ghauri 1, which appeared to be similar to both No-dong 1 and Shahab 3, finally produced the evidence of the co-operative programme between the three countries. It seems that the No-dong 1/2 technologies have been transferred to both Iran and Pakistan and that the Shahab 3 and Hatf 5 (Ghauri 1) missiles are similar to each other. It seems likely that the North Korean engineers tailored the No-dong design to meet specific requirements from Iran and Pakistan. However, there have been unconfirmed reports that both Russian and Chinese engineers have been assisting the Iranian ballistic missile programmes, and that the Shahab 3 developments might be later improvements to the original North Korean design. The Iranians have had problems with manufacturing the Shahab 3 engines, and have used North Korean supplied engines for several of the tests. The first flight test of Shahab 3 was made in July 1998 and two further missiles were displayed in September 1998. An Israeli report suggested that Iran was developing a nuclear warhead for the Shahab 3 missile, but this remains unconfirmed. In September 2000 a Shahab 3-D was tested, which Iran described as a prototype satellite launch vehicle using solid/liquid

The rear view of a Shafiab 3 missile, displayedin Tehranin September 1998, showing the four control vanes and rear wings 0054293

A Shahab 3 missile on its TEL vehicle. displayed in Tehranin September 1998(PA News) 0054294



A line diagram of the Shahab 3 ballistic missile 0089 132

propellants. It is assumed that this indicates the first stage was a standard Shahab 3 liquid-propellant motor, with a solid-propellant second stage. In June 2002 it was reported that Iran is developing a longer range version ballistic missile, designated Shahab 3A, with a range between 1,500 and 1,800 km.

Reports of a further missile development programme, known as Shahab 4, became known in 1997. The initial reports, from Israel, suggested that Shahab 4 was using technologies specifically associated with the former Russian SS-4 'Sandel' (R-12) intermediate-range ballistic missile that had first entered service in 1958. However, this was denied by both Russia and Iran. It seems likely that, following American practice, the design of this now obsolete weapon had been declassified in Russia and made widely available to students and analysts. Pakistan launched a Hatf 5A (Ghauri 2) missile in April 1999, which was a longer version of Ghauri 1 and is believed to have a maximum range of 1,800 to 2,300 km. It is possible that Shahab 4 might be similar to Ghauri 2, but with a range reported to be between 2,000 and 3,000 km. The progress on the development of Shahab 4 is unclear, and there had been no test flights up to July 2002. It is also possible that the original Shahab 4 programme has been terminated, and that a less ambitious Shahab 3A missile project will replace it. Iran has suggested that it is designing a satellite launch vehicle and the Shahab 4 might be intended as a stepping stone in the development of such a vehicle. However, as no further details have been given by Iran, it is difficult to arrive at any firm conclusion. There has been a report that Iran is planning to develop a 4,000 km range ballistic missile, such a missile would also be suitable for use as a satellite launch vehicle and reports suggest that this may have the designator Shahab 5 or Shahab 6. It is thought possible that Shahab 5 is based on the North Korean Taep'o-dong 1 missile or SLV design.

Description

From the available reports it appears that Shahab 3 is similar in size and shape to the North Korean No-dong 1 missile, and is a scaled-up version of the Russian 'Scud B' design similar to the former Soviet R-5 missile. Shahab 3 is believed to be 16.0 m long, with a body diameter of 1.32 m and a launch weight of 16,250 kg. The payload is believed to be 1,200 kg, with a separating warhead encased in a re-entry vehicle. The warhead is believed to be HE, submunitions or chemical with a weight of 800 kg, but a nuclear warhead is probably in development. Alternative details are available for this missile, which suggest that the length is 15.2 m, the body diameter 1.25 m, and the launch weight 15,400 kg. The payload weight is 750 kg. At this point in time we do not know which details are correct. The missile has a single-stage liquid-propellant system and it is believed that this uses IRFNA and kerosene, with around 12,300 kg of propellants and a burn time of 100 seconds. A single motor is fed by a turbopump, with graphite vanes in the exhaust nozzles to control the missile during the boost phase. Guidance is inertial, but it is believed that the missile will not be particularly accurate, most probably with a 2,500 m CEP, although some reports suggest a CEP of nearer 4,000 m. An Israeli report suggested that the Shahab 3-D launch in September 2000 used an improved guidance system, following Chinese assistance, with a possible CEP of 250 m. The minimum range is expected to be around 400 km and the maximum range 1,300 km (although one report suggests 1,350 to 1,500 km). Some of the TELs for this missile are probably converted 'Scud B' vehicles, but it is believed that Iran uses several different types for its 'Scud B' and 'Scud C' missiles, including Russian MAZ 543 TELs, German Mercedes Benz and Japanese Nissan tractor trailer combinations. Reports in September 1998 suggested that Iran may also have converted some IVECO 320-45WTM or Mercedes Benz 3850AS tank transporters as Shahab 3 TEL vehicles.

A report in June 2002 indicated that an improved Shahab 3A missile was in development, and that this version would have a range of between 1,500 and 1,800 km. The payload was believed to be 700 kg, indicating a warhead weight of around 500 kg.

Shahab 4 has been described as using Russian SS-4 technology, which presumably means that it could be similar in size and shape to the SS-4. If this is true, then Shahab 4 would be 22.8 m long, have a body diameter of 1.65 m and a launch weight of 42,000 kg. The payload weight would be up to 1,600 kg, with a separating re-entry vehicle carrying the warhead. The missile would be a single-stage liquid-propellant type, probably using IRFNI and kerosene with a burn time of 140 seconds. The SS-4 motor was an RD-214, with four fixed motor chambers and steered by graphite vanes in the motor exhausts. The motor was fed by a single turbopump, driven by a hydrogen peroxide gas generator and producing a thrust of 635 kN at sea level. The missile had inertial guidance and a maximum range of 2,000 km. The accuracy of an Iranian version might be between 2,500 and 3,500 m CEP. However, an alternative possibility is that Shahab 4 is simply a longer missile than Shahab 3, with more fuel and oxidant, but using technologies taken from the SS-4 programme to improve the performance. This view is reinforced by the Pakistan launch of Ghauri 2 (Hatf 5A) in April 1999, which appeared to be similar in shape to the Ghauri 1 and Shahab 3, but with a range increased to between 1,800 and 2,300 km. If this is correct, then a launch of Shahab 4 could be expected soon and this missile will probably be 18.0 m long, with a launch weight of 16,800 kg. An alternative suggestion is that the Shahab 4 missile uses the RD-216 motors of the SS-5 'Skean' (R-14) ballistic missile, which were also used in the SL-8 Cosmos SLV.

Operational status

Development of Shahab 3 probably started in Iran in 1993 and, in 1997, seven motor tests were reported to have been made. The first flight test was made in July 1998 and USA reports suggested that this was not totally successful, however subsequent reports stated that the missile flew for 1,000 km before being destroyed. It is reported that the Chinese provided a complete telemetry set for this test, and that further sets were delivered later in 1998. The second flight test was made in July 2000, over a range of 850 km according to a US report. A third test was made in September 2000, this time with a Shahab 3-D version, but this flight was unsuccessful according to the US.

A fourth test was going to be made in January 2002, but the missile was destroyed on the ground by fire during the fueling operation. Following this accident it is reported that North Korean engineers spent several months reviewing the whole programme, before a successful fifth test was made in May 2002, when the missile flew around 1,050 km. A report in 1996 suggested that 5 to 12 No-dong type missile assembly sets and motors were delivered to Iran from North Korea, and subsequent reports indicate that up to 20 sets and components had been delivered by mid-2002. A report in 1997 stated that Iran was negotiating with Libya to sell Shahab 3 missiles or technologies to Libya. Initial production of 12 to 15 missiles is believed to have begun in Iran in 1998, and an in-service date of 1999 was reported. It is believed that the missiles will be stored in underground bunkers at five sites, under the control of the Islamic Revolutionary Guard Corps (IRGC). Each of the sites has a launch pad and support facilities. A Shahab 3 motor test, from a TEL vehicle, was reported to have been made at Mashad in February 2000, indicating that the system was now fully road mobile.

The Shahab 4 development programme may have started in 1996, but there have been no confirmed reports that the project is proceeding. A successful motor test was reported in February 1999, following an earlier unsuccessful test in 1998. Iran has made several references to developing a satellite launch vehicle and, if the collaboration with North Korea and possibly Pakistan continues, it is possible that the Shahab 3 and Shahab 4 programmes could contribute to the first stage of a Shahab 5 SLV, probably using the North Korean Taep'o Dong 1 (SLV) as the design.

Specifications

Shahab **3**
Length: 16.0 m
Body diameter: 1.32 m
Launch weight: 16,250 kg
Payload: Single warhead 1,200 kg
Warhead: 800 kg nuclear, chemical, HE or submunitions
Guidance: Inertial
Propulsion: Single-stage liquid propellant
Range: 1,300 km
Accuracy: 2,500 m CEP

Contractors

It is believed that the missile has been designed by the Aerospace Industries Authority, Tehran, and built by Hermat Missile Industries, Tehran.

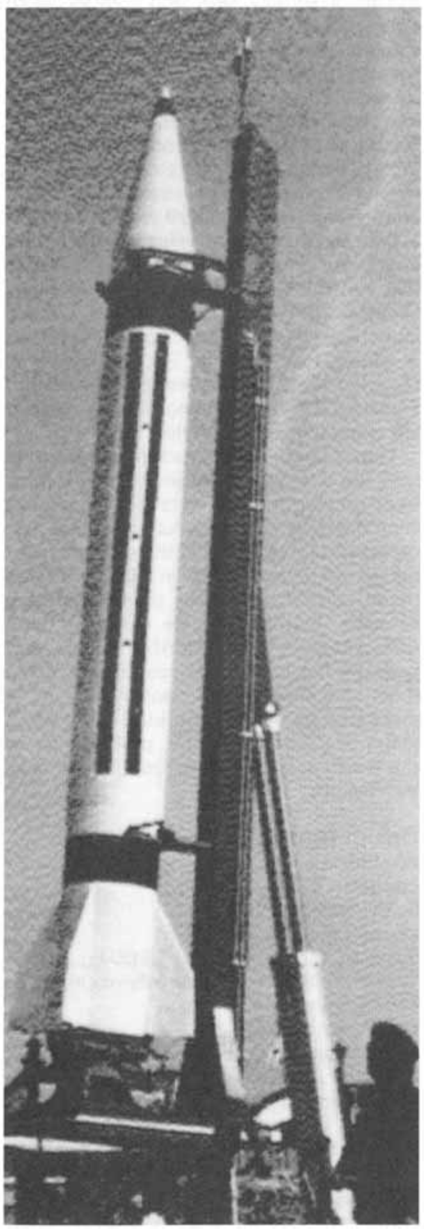
Al Hussein

Type
Intermediate-range, road mobile, liquid-propellant, single warhead ballistic missile.

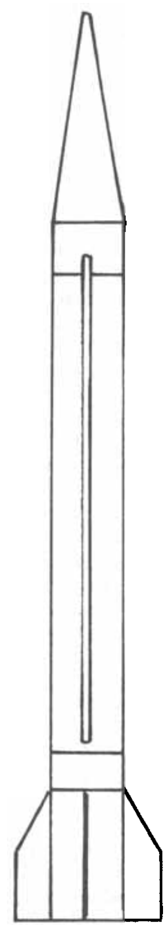
Development
The Al Hussein Short-Range Ballistic Missile (SRBM), also known as El-Hossein or al-Husayn (and Project 1728). was first reported in mid-1987 and was claimed by Iraq to be a newly designed and developed system with a range of 650 km. Other reports suggested that Al Hussein was an Iraqi identification of the Soviet-supplied SS-1c 'Scud B' missile, or even the Brazilian SS-300 which was also thought to be a modified 'Scud B'. Following the sale of between 800 and 1,000 'Scud B' missiles to Iraq, it is now known that Al Hussein is a modified 'Scud B' missile, with a smaller payload and additional propellant to give the increased range. It is believed that the Iraqis probably received assistance from other nations, China, Egypt and France have been mentioned, and that the changes to the 'Scud B' were based upon designs prepared by other 'Scud B' operating countries such as the former East Germany or North Korea. It is interesting to note that reports of a 'Scud C', with increased range, having been developed by the former Soviet Union, might provide the answer to the Iraqi Al Hussein design.

In 1991, Iraq announced the development of an Al Hijara missile, but this was simply an Al Hussein with a concrete warhead. A longer range development was also reported in Iraq called Al Abbas, although it is believed that the Al Abbas programme was terminated in 1990, in favour of an alternative design upgrading the propellants and motor of Al Hussein, to produce a missile with a range of around 1,000 km. Reported test firings in December 1990 are believed to have been connected with a development programme to improve the accuracy of Al Hussein, and possibly to flight test a chemical warhead. Iraq declared 30 chemical warheads for the missiles in late 1991 and these were destroyed. However, reports from the UN Inspection Team in 1995 indicated that Iraq had developed chemical warheads and chemical submunitions for the Al Hussein missile, and that there were still 45 to 70 chemical warheads for the Al Hussein missiles unaccounted for by Iraq. United Nations reports in 1995 confirmed that Iraq had designed and developed a small number of biological warheads for the Al Hussein missile (there were reported to be 25 in total). In addition, in 1997, the UN Inspection Team reported that Iraq had been able to manufacture all the components of the Al Hussein missile and may well have removed components before destroying missiles in 1991.

Description
It is believed that Al Hussein is 12.46 m long, has a body diameter of 0.88 m and a launch weight of 6,400 kg. A payload weight of around 500 kg, reduced from the 'Scud B' weight of 985 kg, would probably carry a single conventional High Explosive (HE) blast/fragmentation or a chemical warhead. The missile has inertial guidance, but no terminal guidance. The Al Hussein has an estimated accuracy of 1,000 m CEP, although an Israeli report suggests that the achieved accuracy during the 1991 attacks was nearer to 3,000 m CEP. It is believed that the Al Hussein missile carries 4,500 kg of fuel and oxidant, using 1,000 kg of UDMH and 3,500 kg of IRFNA.



An Al Hussein SRBM on a mobile launcher
0093153



A line diagram of the Al Hussein missile

An Al-Waleed Transporter-Erector-Launcher (TEL) vehicle. used for the Al Hussein and Al Abbas missiles

There were two Al Hussein versions built, one with six air bottles just behind the warhead bay and one with only two air bottles. The missile has a minimum range of 150 km and a maximum range of 630 km, which represents a significant increase over the 300 km range of a 'Scud B'. Reports indicate that Al Hussein missiles'flight time was about 7% minutes for 600 km range, and that the boost phase motor burn time was between 80 and 85 seconds. The apogee on a 600 km flight is around 150 km and the boost phase motor burn would be complete at an altitude of around 45 to 50 km.

The missile is mounted on an Al-Waleed eight-wheeled TEL (Transporter-Erector-Launcher) vehicle, but it can also be carried on modified SS-1 'Scud B' TEL, the MAZ 543 P and a Daimler-Benz trailer known as Al Nida. A fixed launcher, with the steel support ring mounted on a concrete base, was also used by Iraq in the 1991 Gulf War. Reports from Israel and Saudi Arabia suggest that many Al Hussein missiles broke up on re-entering the atmosphere at around 20 km altitude, most probably due to inadequate design and testing.

Operational status
Development probably started in the early 1980s and the first test firing was reported in August 1987. It is reported that around 190 Al Hussein missiles were fired against Iran during the early months of 1988. Suggestions by Iraq, that it had developed a new ballistic missile, called 'Al Hijara' (The Stones), were found to refer to an Al Hussein version with a concrete warhead. The UN inspection team identified that three Al Hijara missiles were launched during the Gulf War in 1991.

It is reported that Iraq fired between 80 and 90 Al Hussein missiles during the Gulf War, but several failed to fly and 82 were reported to have landed; 43 aimed at Saudi Arabia and 39 at Israel. The missiles launched at Israel were mostly fired in salvoes, with between two and five missiles fired at a time to stress the defending Patriot missiles and to complicate the task of locating the launchers. Following this war, Iraq declared that it had a further 51 Al Hussein missiles, with 23 conventional HE warheads and 30 chemical warheads and six mobile launchers with a further 32 fixed missile launch platforms. The remaining assets were destroyed by the UN monitoring team, who reported that the Iraqis destroyed 78 Al Hussein missiles and that the UN destroyed a further 44. This would establish the total number of 'Scud B' missiles converted to Al Hussein at around 400.

Reports in 1995 confirm, however, that Iraq built both airframes and engines for Al Hussein missiles and that the total number of missiles built could have been considerably higher. Unconfirmed reports suggest that Iraq has stored further Al Hussein missiles in addition to those declared to the UN and that not all the mobile launchers have been destroyed. The numbers stored, but not located by the UN inspection teams, have been estimated at between 15 and 50 'Scud B' and Al Hussein missile missiles together with 10 to 20 TEL vehicles. Some stored missiles may have been removed from Iraq altogether and unconfirmed reports have suggested that these may be in Sudan or Yemen. The UN Inspection Team also believes that some of the chemical and biological warheads developed in 1988-89 are still retained in Iraq, but are not being declared. Shipments of guidance components were being made to Iraq between 1990 and 1995 and, following the expulsion of the UNSCOM inspectors in August 1998, it must be assumed that Iraq will try to re-open its missile production facilities. Continued bombing of suspected Iraqi missile production facilities by the US and UK may have slowed the manufacture of new missiles, but it is possible that the production facilities have been rebuilt underground.

Specifications
Length: 12.46 m
Body diameter: 0.88 m
Launch weight: 6,400 kg
Payload: Single warhead; 500 kg
Warhead: Conventional HE or chemical or biological
Guidance: Inertial
Propulsion: Liquid propellant
Range: 630 km
Accuracy: 1,000 to 3,000 m CEP

Contractor
Not known.

FAW 70/150/200

Type
Short-range, ground-launched, liquid-propellant, single warhead surface-to-surface missiles.

Development
A family of coastal defence missiles, given the Iraqi designators FAW 70, FAW 150 and FAW 200, were first revealed at the Baghdad Defence Show in May 1989. The smallest of the three missiles, FAW 70, appears to be an Iraqi variant of the Russian SS-N-2C 'Styx' missile, basically a 1950s design. It is known that Iraq purchased some 'Styx' missiles from the former Soviet Union and it must be assumed that the Iraqis have further developed these basic designs. The FAW 70 is also similar to the Chinese built HY-1/HY-2, known in the West as the 'Silkworm' missile although given several NATO designators. The Iraqi designs simply lengthened the missiles to carry more fuel, a similar approach to that used to develop the Al Hussein ballistic missiles. Unconfirmed reports suggest that Iraq may have continued to develop the FAW 70 and FAW 150 designs up to 1995, this would have been allowed under the United Nations resolutions which permit Iraq to develop and test missiles with ranges up to 150 km.

Description
The general configuration of the FAW family of coastal defence missiles is similar to the SS-N-2C 'Styx', with folding delta-wings and a triple tail. The FAW 70 has a length of 6.55 m, a body diameter of 0.78 m and a launch weight of 2,500 kg including the solid-propellant boost motor. The missile is believed to have a 500 kg warhead, which might contain either High Explosive (HE) or chemicals. Mid-course guidance is by autopilot, with the terminal phase active radar. It is not known if the Iraqis have developed an Infra-Red (IR) terminal seeker for the FAW. The flight trajectory can be programmed in step heights between 50 and 300 m, followed by a shallow dive onto the target It is believed that FAW 70 has a range of 80 km.

FAW 150 has a similar outline to FAW 70, but the body has been lengthened to about 8.1 m to include an enlarged liquid propellant tank to increase the range to 150 km. The FAW 200 has been further lengthened to about 8.9 m, to further increase the liquid-propellant tank size and to increase the range to 200 km. To utilise such long ranges, the FAW system would require some additional sensor updates to the missiles in flight, this would most probably be provided by forward located ships, aircraft or helicopters.

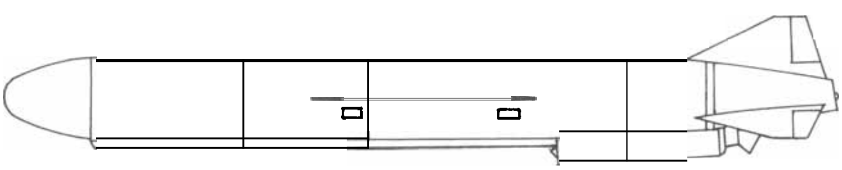
An Iraqi FAW 200 surface-to-surface missile, a modified variant of the Russian SS-N-2C 'Styx' missile, with the range increased to 200 km (Christopher F Foss) 0038248

Specifications

	FAW ***70***	FAW **150**	FAW ***200***
Length	6.55 m	8.1 m	8.9 m
Body diameter	0.78 m	0.78 m	0.78 m
Launch weight	2,500 kg	2,650 kg	2,740 kg
Payload	Single warhead; 500 kg	Single warhead; 500 kg	Single warhead; 500 kg
Warhead	HE or chemical	HE or chemical	HE or chemical
Guidance	Autopilot with active radar	Autopilot with active radar	Autopilot with active radar
Propulsion	Liquid propellant	Liquid propellant	Liquid propellant
Range	80 km	150 km	200 km
Accuracy	n/k	n/k	n/k

Operational status
It is believed that the FAW 70 and 150 completed development in 1990 and are in service in Iraq. It is not known if the FAW 200 development was complete and there have been no reports of firing trials of this version There are no known exports. Several FAW 70 or Chinese built HY-1/HY-2 missiles were fired at ship targets in the 1991 Gulf War, but without success.

exceeding 150 km and it is assumed that all the FAW 200 missiles were destroyed.



A line diagram of the FAW 200 missile

Military Production Authority, Baghdad.

Gabriel

Type

Short-range, ship-, ground- and air-launched, solid-propellant or turbojet-powered, single warhead, surface-to-surface and air-to-surface missiles.

Development

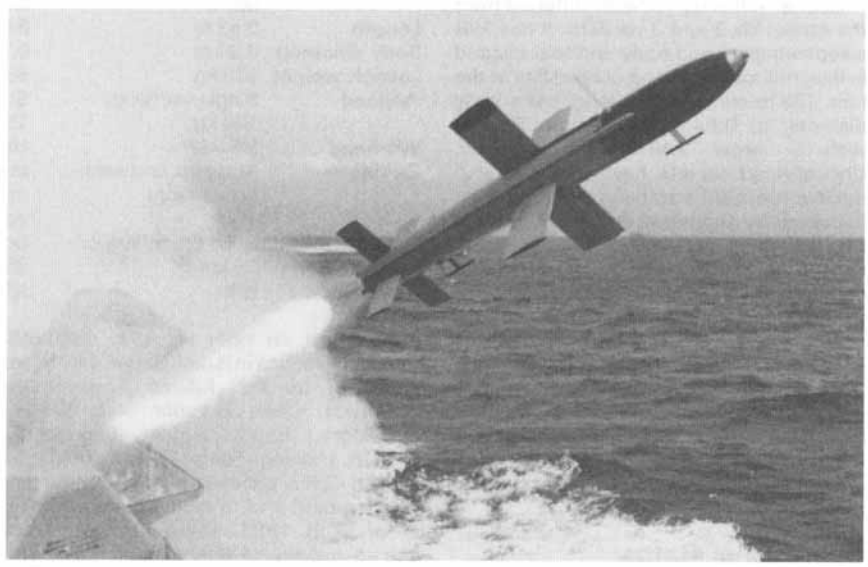
The Gabriel Mk 1 was a ship-to-ship missile developed in Israel during the 1960s. It was first reported in service in 1972, and saw successful service in the Yom Kippur war in 1973. In 1972, development started on an improved version, this was designated Mk 2 and entered service about 1976. It was exported to Taiwan in 1978 and has since been built there under licence where it is known as the Hsiung Feng 1. Gabriel Mk 2 has also been built under licence in South Africa, where it was given the name 'Skorpioen'. It is believed that development began on the Mk 3 in 1979 and it entered service in 1980. An air-launched version, Gabriel Mk 3AS, entered service in 1982 and has been cleared for carriage on A-4 Sky Hawk, Kfir, F-4 Phantom and Sea Scan aircraft.

In June 1985, it was revealed that a long-range version of Gabriel was being developed for ground, ship and air use, designated Gabriel 4LR, and this is believed to have entered service in 1992. In 1997, there was an unconfirmed report that Gabriel 4LR was to be upgraded with a dual-mode active radar and imaging IR seeker. In 1998 it was suggested that Gabriel 4 LR might also be fitted to Dolphin class (type 800) submarines, with a small nuclear warhead. This version would be encapsulated for launch from 533 mm torpedo tubes, similar to the UGM-84 Harpoon. Unconfirmed reports have suggested that the submarine-launched version of Gabriel 4LR had a range increased to 1,400 km, which would require the missile to carry an increased amount of fuel and to be modified with an INS/GPS navigation system. Such a major performance increase would suggest a new missile design, and probably a new designator. In May 2002 a Gabriel 5 missile was proposed, to be called the Advanced Surface Attack Missile (ASAM), which would be fitted to Saar 5 plus corvettes, with 16 missiles carried in each ship. The ASAM would have a maximum range of 200 to 400 km, with an expected in-service date of 2005.

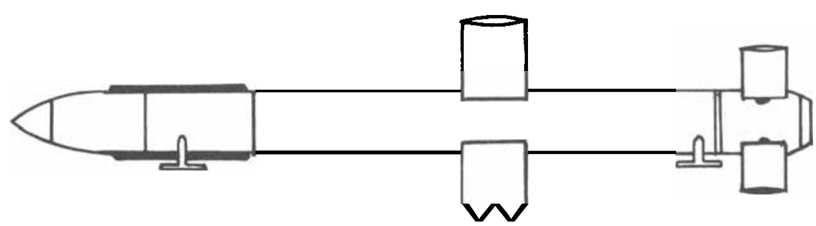
In 1996, Somchem (South Africa) displayed a new submunition warhead for use with Gabriel Mk 2 or 3 missiles; the warhead weighs 150 kg and has 35 self-forging fragment submunitions, each weighing 1.1 kg, together with 39 kg of HE. This new warhead has been designed to penetrate the bulkheads within a ship and it is reported that each submunition can penetrate up to 10 mm steel bulkheads.

A quantity of four or six Gabriel Mk 2 and 3 ship-launched missiles are fitted to 'Hetz' (Saar 4.5). 'Aliya' (Saar 4.5) and 'Reshef' (Saar 4) class fast attack craft; eight missiles are fitted to 'Eilat' (Saar 5) class corvettes; and hydrofoils of the 'Flagstaff class have two launch canisters fitted at the stern. Some missiles may also be used for coastal defence.

A Dvora class missile boat launching a Gabriel Mk 3 missile



A Gabriel Mk 3 surface-to-surface missile just after launch



A line diagram of a Gabriel Mk 3 missile

Description

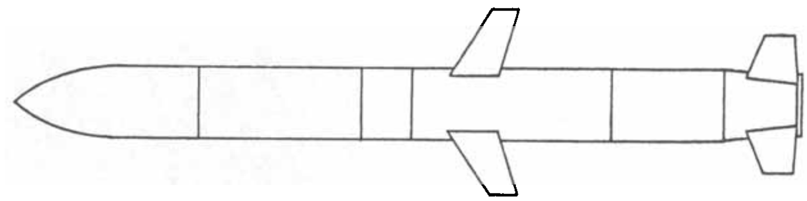
The Gabriel Mk 2 and 3 have the same shape but differ in length. Flight control is by cruciform rectangular moving control tailfins, which are in-line with larger rectangular mid-body wings. The Mk 2 is 3.42 m long, has a body diameter of 0.34 m and weighs 522 kg at launch. Before launch the missile guidance system is programmed with the target data obtained from its associated search radar. It is then fired and, under control of its two gyro autopilot, assumes an initial cruise altitude of about 100 m. At a range of 7.5 km from the launcher the onboard autopilot commands the missile to descend to 20 m altitude using a radio altimeter to maintain the height. At a predetermined distance from the target the semi-active radar is switched on, the target is acquired and the missile descends to one of its three possible preset attack altitudes for the final run in. The actual set altitude varies between 1 and 3 m and depends upon the sea state encountered at

the time. Propulsion is by a solid-propellant boost and sustainer motor. The effective missile range is reported to be 35 km, with a cruise speed of M0.7. The Semi-Armour-Piercing (SAP) warhead weighs 180 kg and contains some 75 kg of conventional High Explosive (HE).

The Mk 3 is 3.85 m long, has a body diameter of 0.34 m and at launch weighs 560 kg with an SAP warhead of 150 kg. The guidance system has three modes of operation plus the additional advantage of an active radar seeker. The first mode (fire and forget) is identical with that of the Mk 2. Using the second mode (fire and update), target data is sent to the missile via a datalink, thus reducing the uncertainty of target location and increasing hit probability. In the final mode (fire and control), the missile can be commanded all the way to the target by the launch ship's fire control radar, which can also receive additional information from other ships or aircraft closer to the target. Propulsion for the missile is by a solid-propellant boost and sustainer motor. The effective missile range is reported to be 35 km with a cruise speed of M0.7.

Gabriel 4LR is significantly different from the earlier Mk 2 and 3 versions. It has four swept-wings at mid-body and four clipped in-line, triangular moving control fins at the rear. The missile is 4.7 m long, has a body diameter of 0.44 m and weighs 960 kg with a larger 240 kg HE warhead. Unconfirmed reports have stated that a nuclear warhead has been developed for this version. Guidance and flight profiles are the same as for the Mk 3 version, except that datalink mid-course command updating is required at the longer ranges over 50 km and it is reported that Global Positioning System (GPS) mid-course updates are provided. Propulsion of the Mk 4 missile is by turbojet, aided by a solid-propellant jettisonable motor for the launch phase, and it is reported to have a maximum range of 200 km although unconfirmed reports have suggested a range as great as 1,400 km.

A Gabriel Mk 3 air-to-surface missile being launched from an F-4 Phantom aircraft (IAI)
0038249



***A** line diagram **of** a Gabriel Mk 4LR missile*

Specifications

	Mk 2	**Mk 3**	**Mk** 4LR
Length	3.42 m	3.85 m	4.7 m
Body diameter	0.34 m	0.34 m	0.44 m
Launch weight	522 kg	560 kg	960 kg
Payload	Single warhead; 180 kg	Single warhead; 150 kg	Single warhead; 240 kg
Warhead	HE SAP	HE SAP	HE SAP
Guidance	Autopilot and semi-active radar	Inertial with command update and active radar	Inertial with command update and active radar
Propulsion	Solid propellant	Solid propellant	Turbojet
Range	35 km	35 km	200 km
Accuracy	n/k	n/k	n/k

Operational status

Gabriel Mk 2 entered service in 1976 and Mk 3 in 1980. It is believed that production has ceased on both versions, but both remain in service in Israel. Gabriel has been exported to the following countries: Argentina, Chile, Ecuador, Iran, Kenya, Singapore, South Africa (Skorpioen), Taiwan (Hsiung Feng 1) and Thailand. Gabriel 4LR is believed to have completed development and to have entered service in Israel in 1992. There have been no known exports of this version. There are unconfirmed reports that a nuclear armed cruise missile, based on the Gabriel 4LR design, has been developed in Israel, possibly for launch from Dolphin (type 800) class submarines as well as from aircraft. Unconfirmed reports have suggested that a 1,400 km range cruise missile had been launched from a Dolphin class submarine in May 2000, but this has been denied by Israel.

Contractor

Israel Aircraft Industries Electronics Division, Yahud.

Jericho 1/2/3 (YA-1/YA-3)

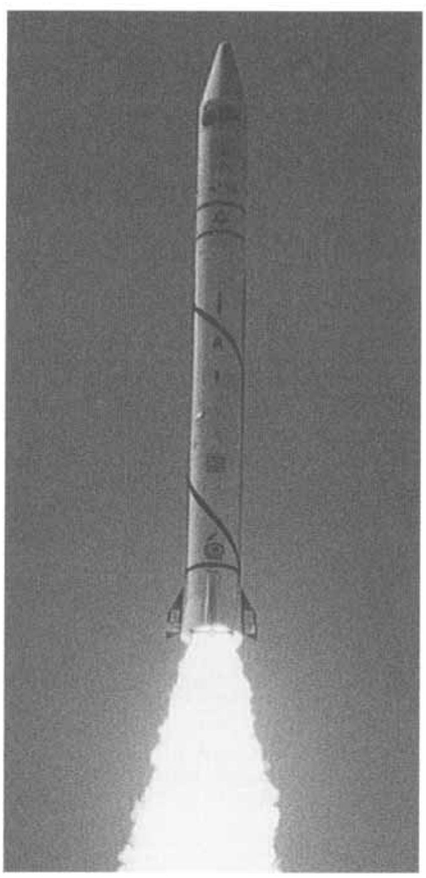
Type

Short- and intermediate-range, road mobile, solid-propellant, single warhead ballistic missiles.

Development

The Jericho 1 missile is reported to have been developed from 1962 with French assistance, based upon a Generale Aeronautique Marcel Dassault (GAMD) design known as MD-620. This SRBM was a two stage solid propellant missile, with a range of around 500 km. A small number of missiles were made in France, and then production was taken up in Israel for the remainder. It is believed that the Israeli name for this missile was 'Luz' and the designator YA-1. There are reports from Iran that an upgraded version of Jericho 1 (perhaps YA-2) was developed in the 1970s. with a payload weight of 800 kg, presumably to carry a larger nuclear warhead.

The Jericho 2 missile development programme started in 1977, possibly with joint funding from Iran for both land-based and submarine-launched versions of the two stage solid-propellant missile. Co-operation with Iran ceased in 1979, but later reports indicate that there was then some co-operation with South Africa on the Arniston (Jericho 2) project during the 1980s. Test firings for the Jericho 2 missile are reported to have taken place from 1986 onwards. Jericho 2 is an intermediate-range ballistic missile, possibly similar to the Shavit space launch vehicle but also similar to the French S-3 ballistic missile, and is believed to have the designator YA-3. There have been four successful Shavit launches, in September 1988, April 1990 and April 1995, an unsuccessful launch attempt was made in January 1998, and a successful launch in May 2002. Unconfirmed reports suggest that a Jericho 3 missile, with a range of 4,800 to 6,500 km, is now in development, possibly similar to proposed upgrades to Shavit with longer first- and second-stage motors.



A Shavit launcher. used to launch the Offeq 3 satellite in April 1995 (IAI)

Description

Jericho 1 is believed to have had a payload capability of 650 kg, with a 450 kg conventional High Explosive (HE)warhead, although some reports suggest a 20 kT nuclear or chemical warhead. The missile was 13.4 m long, had a body diameter of 0.8 m and a launch weight of 6,700 kg. Jericho 1 was a two-stage solid-propellant missile, with four clipped-tip delta stabilising fins at the base of the second stage and a separating warhead assembly. The first stage had a length of 4.05 m and a weight of 1,950 kg, and the second stage had a length of 5.0 m and a weight of 4,100 kg. The payload assembly had a length of 4.35 m and a weight of 650 kg. The solid-propellant motors were made by the Rocket Systems Division of Israel Military Industries. The missile could be launched from railroad flat trucks or from a wheeled Transporter-Erector-Launcher (TEL) vehicle. The maximum range of Jericho 1 was believed to be 500 km, and an accuracy of 1,000 m CEP has been reported.

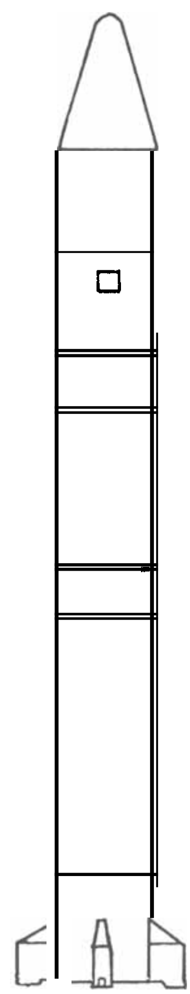
It is reported that Jericho 2 has two solid propellant stages, has a length of 14.0 m, with a body diameter of 1.56 m and a launch weight of 26,000 kg. The motors are manufactured by Israel Military Industries, who make the solid-propellant motors for the Shavit SLV and Arrow ABM system. The first stage motor burns for 52 seconds and the second stage for 85 seconds, with boost burn completed at around 105 km altitude. An alternative launch weight of 21,935 kg has also been reported, with a first stage weight of 10,970 kg and a second stage weight of 9,965 kg. The payload capability is probably 1,000 kg, which means that either nuclear (possibly 1 MT) or conventional HE warhead options could be used. It is reported that the Jericho 2 warhead separates after the boost phase of flight. It is believed that the missile has inertial guidance and that the re-entry vehicle may also have a radar image correlation system for terminal guidance. Jericho 2 is reported to be located in underground caves and silos, but it is believed that the missile is also road mobile with a wheeled TEL, or can be launched from railroad flat trucks. The missile is reported to have a maximum range of 1,500 km. However, the capability of Jericho 2 is such that it could have a range considerably greater than 1,500 km with a 1,000 kg payload, probably around 3,500 or 4,000 km. The TEL vehicle used to launch Jericho 2 is believed to be 16 m long and is supported by three vehicles for command and communications, site survey and weather.

Jericho 3 is believed to be a three-stage solid propellant missile, around 15.5 m long, with a body diameter of 1.56 m, and a launch weight of 29,000 kg. The maximum range is probably between 4,800 and 6,500 km. It is possible that this missile could have a payload of 1,000 to 1,300 kg, with a single 750 kg nuclear warhead, or even two or three MIRV.

Operational status

Jericho 1 is thought to have entered service in 1973 and Jericho 2 in 1989, with unconfirmed reports that between 50 and 100 Jericho missiles have been deployed in underground bunkers. A total of 14 Jericho 1 missiles are believed to have been delivered from France, with a further 50 built in Israel between 1971 and 1978. It is believed that there were 16 test launches of Jericho 1 between 1965 and 1968, with 10 flights rated as successful.

There have been several reported Jericho 2 test firings since 1986, with achieved ranges of 465 and 820 km respectively on the first two (in 1986 and



An outline diagram of the Jericho 2 intermediate-range ballistic missile

1987). An unconfirmed report in June 1989 suggested that a missile similar to Jericho 2 was positioned on a launcher just north of Cape Town in South Africa. It is not known whether this missile was a Jericho 2 being tested at full range or a separate new South African missile called Arniston, but unconfirmed reports suggest that South Africa had jointly funded the Jericho 2 programme with Israel. The July 1989 launch from South Africa flew 1,400 km and is believed to have been a Jericho 2 missile test. Subsequent flight tests are believed to have been made by Israel in September 1989, two further tests between 1990 and 1996, a seventh test in April 2000, and the eighth test in June 2001 from the Palmahim flight test centre near Tel Aviv.

The Jericho missiles are based at Zacharia, southeast of Tel Aviv; satellite images suggest that there are no launch silos and that all the missiles are stored in caves. It is believed that there are around 90 operational Jericho 2 missiles on the site, and that the Jericho 1 missiles have all been taken out of service. Jericho 3 is reported to be in development, with an estimated in-service date of 2005.

Specifications

Jericho 1
Length: 13.4 m
Body diameter: 0.8 m
Launch weight: 6,700 kg
Payload: Single warhead; 450 kg
Warhead: Conventional HE, nuclear 20 kT or chemical
Guidance: Inertial
Propulsion: 2-stage solid propellant
Range: 500 km
Accuracy: 1,000 m CEP

Jericho 2
Length: 14.0 m
Body diameter: 1.56 m
Launch weight: 26,000 kg
Payload: Single warhead; 1,000 kg
Warhead: Conventional HE or nuclear 1MT
Guidance: Inertial
Propulsion: 2-stage solid propellant
Range: 1,500 to 3,500 km
Accuracy: n/k

Contractor

Israel Aircraft Industries, Ben Gurion Airport (prime contractor).

AGM-142 Popeye 1/2 (Have Nap/Have Lite)

Type

Short-range, air-launched, solid-propellant, single warhead, air-to-surface missiles.

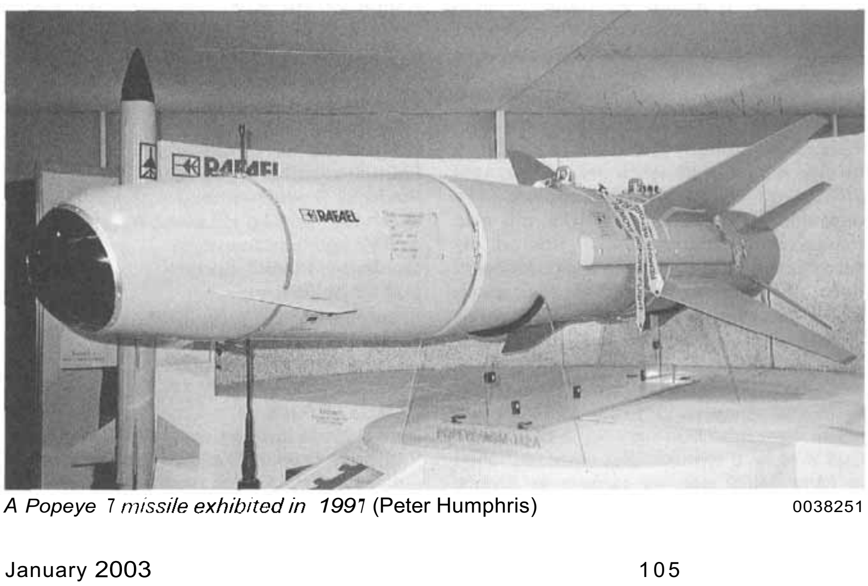
A Popeye 2 trials missile and its datalink pod being carried on the two mid-wing pylons of an F-16 fighting Falcon aircraft (Rafael) 0038250

Development

Development of the Popeye missile began in the early 1980s by Rafael, in order to provide the Israeli forces with a TV-guided standoff weapon for use against high-value ground targets such as airfields, bridges and bunkers. It is believed that Popeye's development was based on the earlier Pyramid TV-guided bomb, and on experience gained with operating AGM-65A Maverick ASMs bought from the USA. Development continued through the mid-1980s and after successful testing, production of the Popeye 1 started in 1989. After trials in the USA in the late 1980's. the USAF awarded an initial test and evaluation contract to prove the missile on the B-52 bomber. under the 'Have Nap' tactical ASM programme. The evaluation trials proved successful and Popeye 1 entered service with the USAF in 1990. having been given the US designation AGM-142A. During the early 1990s. the USAF carried out trials with AGM-142 missiles fitted with an Imaging Infra-Red (IIR) seeker instead of the original TV system. As a result, the weapon can now be fitted with a Line Replacement Unit (LRU) that contains either a TV or IIR seeker, depending on the mission requirements. The IIR seeker version is known in the USA as AGM-142 B. AGM-142 Popeye 1 is believed to have been cleared for carriage by the Kfir and F-4 Phantom and was cleared from the B-52H bomber, F-15 Eagle and F-111 during the USAF evaluation programme.

Further development in Israel in the late 1980s to the early 1990s produced a smaller variant known as Popeye 2 or 'Have Lite'. Rafael has introduced lighter electronics and a shorter rocket motor, reducing the weapon's weight to 1.135 kg. This allows aircraft such as the F-16 and F/A-18 to carry two missiles together with the associated datalink pod. The warhead remains the same and the maximum range is understood to have been reduced by only 3 per cent. Drop tests of Popeye 2 were carried out in 1994 from an Israeli Air Force (IAF) F-16 Fighting Falcon.

In order to provide both variants of Popeye with an improved capability against hardened targets, a new warhead, referred to as the I-800, was developed as an alternative warhead to the original High Explosive (HE) blast type. The 1-800 is a special purpose HE penetration warhead, which was being developed as an optional upgrade for the AGM-84E SLAM-ER ASM. The penetrator warhead versions of Popeye are designated AGM-142C for the TV-guided version and AGM-142D for the imaging IR guided version. Training missiles for the USAF are designated ATM-142. Between 1990 and 1996, there are believed to have been two product improvement programmes for the AGM-142 missile system, including the use of improved electronic components and software. and making the system easier to use. The latest versions are designated AGM-142E/F, and these are believed to have a 1553 databus interface as well as a longer range. There is also reported to be an option to fit a GPS receiver to augment the mid-course guidance. In 1994, it was reported that Rafael had proposed a variant of the Popeye missile to the UK, called Popeye 3.



A Popeye 1 missile exhibited in 1991 (Peter Humphris) 0038251

It is believed that Popeye 3 would be fitted with a turbofan engine, providing a maximum range in excess of 200 km. The UK did not select Popeye 3 but, in 1998, there were reports that Israel was continuing with design studies for a turbojet powered Popeye 3 version. In 2000, Rafael released details of a Smart Precise Impact Cost Effective (SPICE) add-on guidance kit for Mk 84 bombs, based upon the Popeye seekers, datalink and guidance/control system.

Description

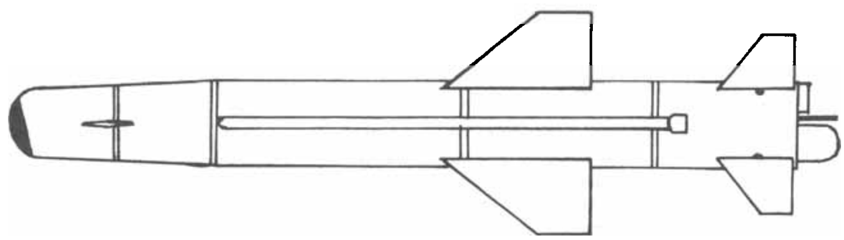
AGM-142A/B/C/D/E/F Popeye 1 is a short-range, TV- or IIR-guided ASM, powered by a solid-propellant motor and armed with either a standard HE warhead or a special purpose penetration warhead. It is cylindrical in shape with a tapered rounded glass domed nose-section that has two small canard stabilisers, four clipped delta wings just aft of mid-body and four smaller clipped-tip triangular moving control fins at the rear. The flying surfaces are configured in an unusual way, with the lower wings longer than the upper ones and the horizontal and vertical spans are different. The missile is of modular construction and is made up of five sections. An interchangeable nose-section, that contains either a TV or IIR seeker; guidance and control section, containing a digital computer for data processing and control functions, inertial navigation system and power supplies. An armament section contains the warhead, safety and arming mechanism and the forward mounting suspension lug. The motor section has the rear suspension lug and the solid-propellant combined booster/ sustainer motor, around which are the four fixed-wings in a cruciform configuration. The rear section is clustered around the motor exhaust, and houses the control servos and actuators for operating the inline control fins.

The motor exhaust nozzle exits bottom centre of the end plate, with the domed datalink antenna mounted above it and protected from the exhaust gas by a semi-circular metal plate. There is a long cable duct/strake joining the rear section to the

guidance and control section. The missile is 4.82 m long, has a body diameter of 0.53 m, an upper horizontal wingspan of 1.57 m, a lower horizontal wingspan of 1.73 m, a vertical wingspan of 1.07 m and a launch weight of 1,360 kg. Popeye 1 can be fitted with either a 350 kg HE blast/ fragmentation warhead or a 352 kg HE penetration warhead to attack hardened targets. The blast/fragmentation warhead has a length of 1.35 m, a diameter of 0.37m and contains 150 kg of HE. This warhead has two FMU-124 fuzes. The penetration warhead has a length of 1.58 m, a diameter of 0.31 m and contains 77 kg of HE. This warhead has two FMU-143 fuzes. Guidance is reported to be inertial with optional updates, followed by terminal TV or IIR guidance. The TV seeker uses a gimballed CCD vidicon camera with autofocus and fields of view adjustable between 1.5 and 9". The imaging IR seeker is gimbaled, uses closed cycle cooling and has two fields of view that can be set to 1.4 or 4°. A digital datalink is used between the missile and the launch aircraft, with the operator setting his target marker on the display screen over the selected target. The missile guides automatically to the designated target. The launch aircraft has to carry an AN/ASW-55 datalink pod, which hasa length of 3.53 m, a diameter of 0.53 m, a weight of 865 kg and has separate forward and rearward facing aerial assemblies. The datalink pod also has an in-flight video recorder. AGM-142A/B/C/D is believed to have a maximum range of 80 km and an accuracy of 3 m CEP, and an unconfirmed report suggests that the AGM-142E/F versions have a maximum range of 90 km and an accuracy of less than 1 m CEP. The missile can be delivered in several different modes, including low-level, pop-up, high-low, or with a steep dive down onto the target.

Popeye 2, known in the US as AGM-142 Have Lite, has a similar external configuration to Popeye 1. However, by reducing the motor length, deploying a lightweight but improved computer and lighter navigation and control systems, the overall weight has been reduced to 1,135 kg. It is reported that Popeye 2 is 4.25 m in length, operates in the same manner as Popeye 1 and can be fitted with the same choice of seeker heads and warheads. The wings and fins are improved to increase the range, and a GPS receiver is fitted. Popeye 2 has a reduced range of 75 km.

Two AGM-142 missiles in tandem beneath the port wing of a B-52 bomber. Note the rear datalink antenna on the aft end of the rear missile and the datalink pod under the starboard wing (Lockheed Martin)



A line diagram of the AGM-142 Popeye missile

Operational status

Popeye 1 entered production in 1989 and is in service with the IAF. Initial operational evaluation by the USAF was completed in 1990, following seven successful trials out of eight firings. Delivery of a further 86 missiles and four guidance pods took place in 1990-91. The USAF have ordered over 200 AGM-142 Have Nap missiles and at least 30 missiles are reported to have IIR seekers replacing the earlier TV systems. Popeye 2 was first exhibited in 1994 and drop tests were made in 1995 from an Israeli F-16 aircraft. It is believed that Popeye 2 entered service in Israel in 1995. Lockheed Martin signed an agreement with Rafael for second source production in the US, whenever the USAF places further orders for the missile system or export orders are received. Production in the USA is being undertaken by a joint venture company known as Precision Guided Systems United States (PGSUS), and the first flight test of a US-built missile was made in September 2000. An export order has been placed by Australia for 90 missiles, for use from its F-111C/G aircraft. In 1997, it was reported that Turkey would purchase 30 and manufacture a further 120 Popeye 1 missiles under licence and that South Korea would purchase 116 missiles. South Korea ordered further missiles in September 1999, believed to be 40 AGM-142C and 60 AGM-142D versions. In 1998, it was reported that Turkey had modified its order to 200 missiles in total, including both Popeye 1 and 2 versions for carriage on F-4 upgraded Phantom and F-16 Fighting Falcon aircraft. Israel ordered 45 AGM-142D Popeye missiles from the PGSUS consortium in the USA in 1998, a further 41 missiles were ordered in April 2000, and 40 AGM-142F missiles were ordered in July 2001. PGSUS will also manufacture the missiles ordered by Australia and the USA, with a total believed to be 250 missiles ordered for delivery by 2003. An order for Popeye 1 and 2 missiles for Greece was reported in 1999, but this has not been confirmed.

It has been reported that some AGM-142 missiles were launched by the USAF from B-52 bombers during the 1991 Gulf War, and two missiles were launched in May 1999 against targets in Serbia. There were software problems with the two missiles launched in 1999, and following changes two tests were made in October and November 1999 to confirm that both TV and IIR guided missiles worked successfully.

Specifications

AGM-142 Popeye 1
Length: 4.82 m
Body diameter: 0.53 m
Launch weight: 1,360 kg
Payload: Single warhead
Warhead: 350 kg HE blast/fragmentation or 352 kg HE penetration
Guidance: Inertial, update and TV or IIR
Propulsion: Solid propellant
Range: 80 km (A/B/C/D) or 90 km (E/F)
Accuracy: 3 m CEP (A/B/C/D) or 1 m CEP (E/F)

Popeye 2
Length: 4.25 m
Body diameter: 0.53 m
Launch weight: 1,135 kg
Payload: Single warhead
Warhead: 350 kg HE blast/fragmentation or 352 kg HE penetration
Guidance: Inertial, update and TV or IIR
Propulsion: Solid propellant
Range: 75 km
Accuracy: n/k

Contractors

Rafael, Haifa (prime contractor).
Precision Guided Systems United States, Orlando, Florida, USA (second source).

Sea Killer/Marte

Marte 2 missile fitted to an Italian Navy Agusta SH-3D helicopter

Type

Short-range, ship- or air-launched solid-propellant, single warhead, anti-ship missiles.

Development

Development of the Sea Killer/Marte family of anti-ship missiles was started in 1963, as a private venture by Contraves Italiana Spa. The initial requirement was for a new generation, ship-launched, sea-skimming, anti-ship missile. In 1966, a prototype command-guided missile called Nettuno appeared, and was experimentally operated on a 'Freccia' class fast attack craft. In the meantime, development and marketing of the system had been passed to an Italian consortium, Sistel Spa. Sistel (Sistemi Elettronici) was established in 1967 and it was this organisation which developed a longer ranged version, Vulcano. with two-stage propulsion, and a Sea Hunter 4 (ADT A40) fire-control radar system. Development of the Vulcano missile began in 1965 and the prototype appeared in 1969. At about this time the two missile systems were renamed; Nettuno became Sea Killer Mk 1 and would be used for training, while the longer range Vulcano became Sea Killer Mk 2 and would be for operational use.

The Italian Navy did not purchase either of these missiles preferring the French/Italian Otomat missile (see separate entry). However, the Imperial Iranian Navy purchased the Sea Killer system for its 'Saam' (later Alvand 'Vosper Mk 5') class frigates of which the first, *Zaal* (later ***Alborz***), was commissioned in March 1971. However, in 1975 Oto Melara (later Alenia Marconi Systems and now MBDA, part of EADS) began development of an air-launched variant of Sea Killer 2 with an active radar seeker, for use from helicopters. The seeker used was a derivative of their large diameter Teseo radar seeker, and resulted in the new missile, which used the original airframe, having an unusual bulbous nose. The new missile was named Marte because of its integration into the Marte heliborne radar system.

Prototypes of the Marte 1 missile were delivered to the Italian Navy for evaluation in 1977. Production of the missile began in 1978 and throughout 1979 a series of 10 test firings were carried out, using SH-3D Sea King helicopters. These were followed in 1980 by a series of 15 test firings, mainly to evaluate the radar tracking capability. Marte 1 entered service with the Italian Navy in 1983 carried on Agusta-3D helicopters; it was also cleared for carriage on Agusta Bell 212 helicopters, which were redesignated AB 212 ASW when equipped with the Marte 1 system. An improved variant Marte Mk 2, fitted with an Otomat active radar seeker, was first displayed at the 1983 Paris Air Show. Test firings of the Marte Mk 2 were carried out throughout 1984-86 and the missile entered service in 1987. It is believed that all the earlier Mk 1 missiles were modified up to Mk 2 standard.

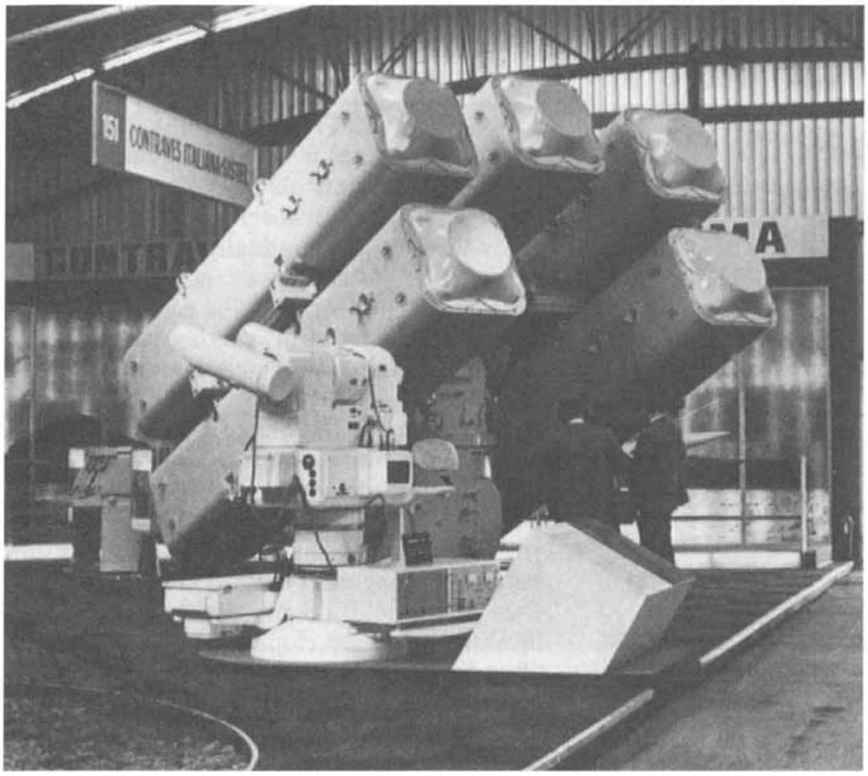
At the 1990 Farnborough Air Show, two more variants of Marte 2 were displayed. Marte 2A is a fixed-wing aircraft-launched version designed for use with small aircraft, such as the MB-339 and AMX. On this variant, the large tandem jettisonable booster motor has been removed and replaced with a small internal motor. A study was reported to be in progress in 1996 to develop a dual-mode active radar and Imaging Infra-Red (IIR) terminal seeker for Marte 2A. The second variant, Marte 2H, was a folding-wing version with the large tandem boost motor replaced by an underbody one, for use from helicopters, but this design was not continued.

In the early 1990s. a shipborne version of Marte 2 was reported, known as Marte 2N, intended to provide smaller warships with an attack capability. The early Marte 2N missile was virtually the same as the helicopter version, except for folding wings and variable geometry fins to reduce the size of the launcher container. In 1997, a new layout for the ship-launched and helicopter-launched versions was proposed, with two solid-propellant boost motors attached one each side of the rear missile body. These missiles have the designators Marte 2N for the ship-launched version and Marte 2S for the helicopter-launched version. The active radar seekers have been upgraded for use in littoral warfare and insensitive warheads and motors are fitted. Marte 2N may also be offered for use as a coastal defence weapon system.

The next missile in the Marte 2 family was an anti-radar version designated Marte 2B. The main changes for Marte 2B were the use of an anti-radar seeker and a fragmentation warhead. The missile was intended for installation on fixed-wing aircraft, but the programme was terminated in 1993. In 2000, some Marte 2 shaped missiles were reported in Iran, fitted onto trucks for coastal defence. These could be modified Sea Killer Mk 2 missiles, modified Marte 1 missiles, or Marte 2.

The Marte 2 and 2S have been cleared for carriage on Agusta SH-3D and Agusta Bell 212 ASW helicopters. The Marte 2A has been cleared for the MB-339 and the AMX aircraft. The Marte 2S will be fitted to

A Marte 2S missile displayed at Farnborough in 1998 (Duncan Lennox) 0054291



The Sea Killer Mk 2 quintuple launcher system with the associated search and hre control and main control console, on display in 7977

EH 101 Merlin and NH 90 helicopters, and may also be cleared for carriage on the Super Lynx helicopter. The Marte 2N is being offered for fitment to small ships, with combinations of four cell launchers carrying four or eight missiles.

Description

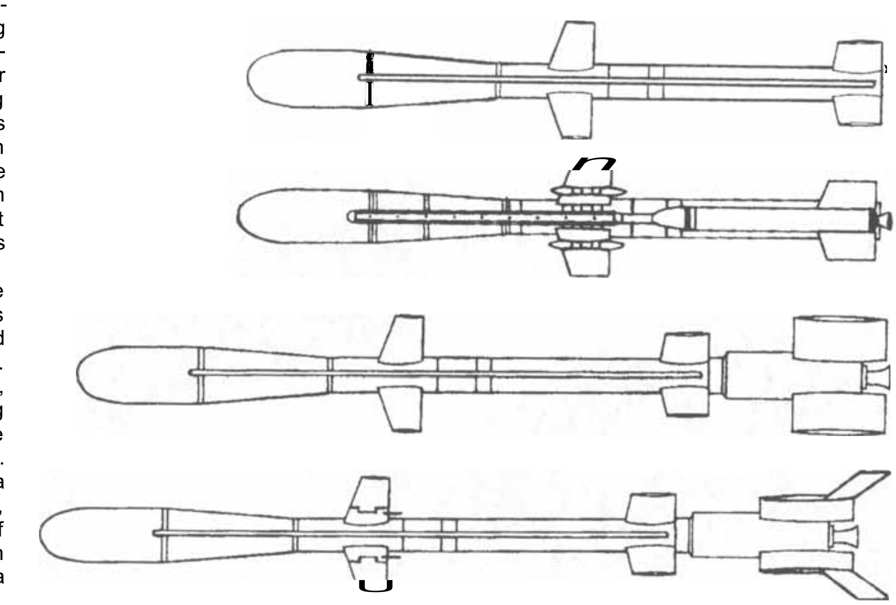
The Sea Killer Mk 2, ship-launched, anti-ship missile system consists of the missile, a fire-control system and a handling-launching system. The missile itself is a short-range, command-guided weapon, powered by a solid-propellant motor system and armed with an HE Semi-Armour-Piercing (SAP) warhead. It has a cylindrical body with a pointed nose-section, four clipped-tip triangular moving control wings at mid-body and four clipped-tip triangular fixed fins at the rear. The rear fins are fitted with rearward facing command receiving aerials. The missile is fitted with a large cylindrical tandem booster motor that has four large rectangular stabilising fins, in a cruciform configuration, and an exposed exhaust nozzle. The boost motor and fin assembly is jettisoned in flight after use.

The Sea Killer missile is made up of three major sections. The nose-section contains the 70 kg HE SAP warhead, delayed impact fuze and safety and arming devices. The control section has the radar receiver, radio link receiver, radio altimeter and wing actuators. The motor section contains the SEP 300 solid-propellant sustainer motor. The 1.08 m long jettisonable motor is a SEP 299 solid-propellant rocket motor, which is capable of delivering 4,400 kg of static thrust. The missile at launch is 4.7 m long, has a body diameter of 0.21 m, a wingspan of 1.0 m and weighs 300 kg. Guidance in the azimuth plane follows the radar line of sight, with angular errors adjusted by transmitted commands to the missile control surfaces. The height is maintained by the radio altimeter which allows a sea-skimming trajectory to be flown down to 3 m above the surface and which can be programmed by radio command during flight from the launch ship. In severe radar jamming conditions the missile can be tracked by a TV camera and is guided by radio commands. Sea Killer Mk 2 has a range of 25 km.

The Sea Hunter 4 fire-control system was designed for surface and air defence engagements with both missiles and guns. It consists of two I/J band radars with separate antennas sharing the same four axis stabilised director. The fire-control system consists of a simple console linked to the Sea Hunter system. Radar data acquired by the Sea Hunter directors can be combined with data from other ships radars; in the case of the Iranian frigates the AWS 1 air/surface search radar and Racal Decca 1226 surface search radar. In addition, data may be accepted from optical target designation systems. The launcher system consists of a pedestal and five launcher-containers each with a frangible cover. It weighs approximately 5,000 kg, can traverse 360" at a speed of 30°/s, and has an elevation of –15 to +30° at a speed of 20°/s.

The Marte family of air-launched anti-ship missiles are basically updated Sea Killer Mk 2s, and have the same general layout, but are distinguishable by their bulbous nose. The original helicopter rack-released version, designated Marte 2, used the same warhead, wings and control system and sustainer and booster motors. However, the new nose-section houses the active radar homing head, inertial guidance section and radio altimeter. At launch the Marte 2 missile is 4.8 m long, has a maximum body diameter of 0.32 m, a wingspan of 0.98 m and weighs 340 kg. The tandem booster motor is jettisoned in flight after 1.7 seconds when the missile has reached a speed of 250 m/s. The missile has a 70 kg HE SAP warhead, and a maximum range of 25 km. The fixed-wing aircraft rail-launched version, designated Marte 2A, differs in that the large jettisionable motor has been replaced with a small internal coaxial solid-propellant motor. Marte 2A is 3.79 m long, has a maximum body diameter of 0.32 m, a wing span of 0.98 m and weighs 269 kg. The missile has four digital datalink antenna on the rear fins, indicating the capability to update the missile in flight with the target position. Marte 2A has a 70 kg HE SAP warhead, and a maximum range increased to 30 km.

The Marte system has three different modes of operation, radar, manual and visual, with each suited to particular


Line diagrams of the Marte 2 family of missiles; top 2A, 2S and 2N, 2, and lower 2N (first version)
0054292

Specifications

	Sea Killer Mk 2 SSM version	Marte 2 helicopter-launched ASM	Marte 2A aircraft-launched ASM	Matte 2N ship-launched SSM	Marte 2S and 2N helicopter-launched ASM version
Length	4.7 m	4.8 m	3.79 m	5.0 m	3.8 m
Body diameter	0.21 m	0.32 m	0.32 m	0.32 m	0.32 m
Launch weight	300 kg	340 kg	269 kg	344 kg	324 kg
Payload	Single warhead	Single warhead	Single warhead	Single warhead	Single warhead
Warhead	70 kg HE/SAP	70 kg HE/SAP	70 kg HE/SAP	70 kg HE/SAP	75 kg HE/SAP
Guidance	Command	Inertial and active radar	Inertial and active radar, with updates	Inertial and active radar	Inertial and active radar with updates
Propulsion	Solid propellant	Solid propellant	Solid propellant	Solid propellant	Solid propellant
Range	25 km	25 km	30 km	20 km	25 krn
Accuracy	n/k	n/k	n/k	n/k	n/k

tactical situations. In the radar mode, after the target has been designated by the pilot or operator on the radar display, relevant data is fed to the Marte system, which computes the final missile heading and time of flight before seeker activation. The missile is launched within its maximum range and is accelerated to cruise speed while descending to attack altitude; which is pre-selected by the pilot according mainly to target configuration. The guidance systems uses a radar altimeter in the vertical plane, and inertial reference in the horizontal plane. Some 10 km to the computed future position of the target, the active homing head is switched on and the missile is controlled to impact. Warhead detonation is by impact delay or proximity fuze. If no radar is available on the launching platform, then the manual mode can be selected. In this mode, target data (range and bearing) can be inserted manually in the system. Operation is the same as in the radar mode, with some degradation due to the reference to the present target position instead of the computed further point. In the visual mode the missile is launched with the aircraft heading aligned on target. The seeker is activated immediately after launch and locks onto the nearest target in a narrow front sector.

The early Marte 2N, ship-launched version was almost identical to the Marte 2 heliborne version, but with folding-wings and flip out variable geometry fins to reduce launcher-container dimensions. The missile's length was increased to 5.0 m. The ship-launched system consisted of two or four missiles housed in fixed inclined launcher containers, a firing control unit for the automatic tracking of the acquired target and missile allocation, and a peripheral firing unit for the control of the launching sequence and power supply units for the launcher containers. The system operation requires additional units that are usually installed on the ship (for example the radar, anemometer, or gyrocompass). The normal method of attack from small fast boats would probably be in the visual mode (see above), and the early Marte 2N had a maximum range of 20 km.

The later Marte 2N and 2S ship-launched and helicopter-launched missiles have two solid-propellant boost motors attached one either side of the missile rear body. The missile is 3.8 m long, has a diameter of 0.32 m and a launch weight of 324 kg. The warhead is an insensitive munition, an HE SAP type and has a weight of 75 kg. The missile has inertial guidance using a strap-down system, with a radar altimeter for mid-course guidance, enabling pre-programmed trajectories and waypoints to be placed into the missile before launch. The missile has four digital datalink antenna on the centre wings, indicating the capability to update the missile with target position during flight. The active radar seeker (8 to 10 GHz X-band) has been upgraded with digital data processing especially to handle targets close to the shore in littoral warfare. The solid-propellant boost and sustainer motors are both insensitive munitions, and give the missile a flight speed of 270 m/s and a maximum range of 25 km. The Marte 2S and 2N missile systems have a common set of units, comprising a missile computer unit and an interface unit.

Operational status

Sea Killer Mk 2 missiles entered service on Iranian 'Alvand' class frigates in 1971, and it is reported that some 120 missiles and four launchers were delivered. The system saw operational service in the Iran-Iraq war when one of the frigates was sunk. It is estimated that about 50 per cent of the original stock remain in service. The Sea Killer Mk 2 missiles were removed from two of the frigates in 1996/97, but a third frigate still has two missiles fitted, although these are expected to be replaced with C-802 missiles. In 2000, it was reported that some converted Sea Killer Mk 2, or modified Marte 1/2 missiles were fitted to trucks in Iran for coastal defence. It has also been reported that some ship-launched Marte 1 missiles were exported to Libya, Peru and Venezuela.

Production of the air-launched Marte 1 began in 1978 and the missile entered service with the Italian Navy in 1983, on Agusta-3D helicopters. Marte 2 started development in 1980 and entered service with the Italian Navy in 1987. There have been no reported export orders for Marte 2. Marte 2A was cleared for use on the MB339 light attack/trainer aircraft in 1995, and for use on the AMX aircraft in 1999. The most recent versions, Marte 2N and 2S, were proposed to the Italian Navy in 1998, and a development contract was placed in 1999. Flight trials from the NH 90 and EH 101 helicopters started in 2000, and Marte 2N and 2S missiles are expected to enter service in 2001/2002.

Contractor

MBDA Missile Systems, Rome.

A Marte 2A missile exhibited at Paris in 1999, showing the command datalink antenna on the rear fins (Peter Humphris)
0089922

SSM-1 (Type 88, Type 90 and Type 96)

Type
Short-range, ground- and ship-launched, turbojet-powered, single warhead, Surface-to-Surface Missile (SSM).

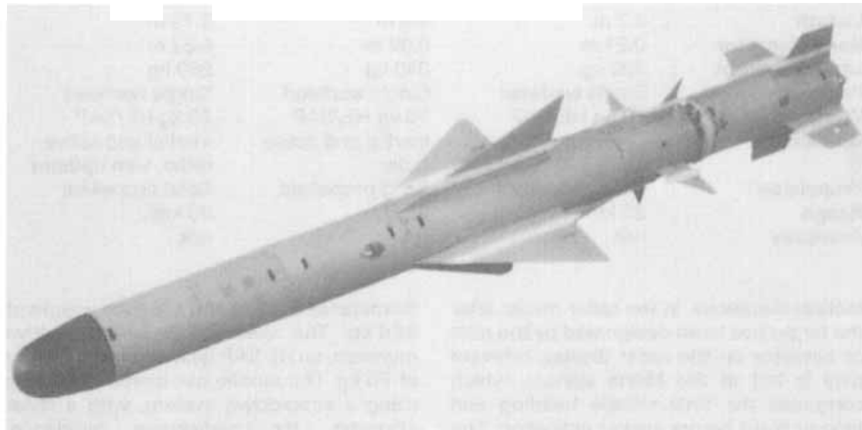
Development
Development of the Type 88 SSM-1A ground-launched coastal defence anti-ship missile began in 1982. The programme was the joint responsibility of the Japanese Defence Agency's Technical Research and Development Institute and Mitsubishi Heavy Industries. Based on the Type 80 ASM-1 air-launched anti-ship missile. but introducing a turbojet engine for longer range, the first prototype weapons were built in 1983, with the first trial launches taking place in 1985. The test programme was completed in 1987 with the first production round deliveries being made in 1988.

A coastal defence and ship-launched version, Type 90 SSM-1B, has also been developed and production started in 1990 for ship-launched missiles and on an order for a coastal defence system in 1994. The ship-launched SSM-1B (Type 90) missiles are fitted to two modified 'Asagiri'class and 'Murasame' class destroyers, with eight missile canisters, and three Italian Sparviero type fast attack hydrofoils with a quadruple launcher. It is planned that SSM-1B missiles will be fitted to 'Takanami' class destroyers, with two quadruple launchers, and to 'Hayabusa' PG 04 class FAC with four missile canisters. A Type 96 missile entered production in 1996, and has been described as a multi-purpose missile, but it is believed to be an upgraded Type 90 capable of use as an air-to-surface missile. A Type 93 ASM-2 was developed from the SSM-1 design with Imaging Infra-Red (IIR) terminal guidance and production started in 1993, and it is assumed that the Type 96 uses a common design.

Development of a longer range XSSM-2 missile is believed to have started in 1994, and this programme is expected to reach completion in 2002. This missile is reported to be vertically launched, to use target recognition algorithms, and is expected to have a maximum range of 250 km. This missile may be capable of attacking land targets, as well as ships.

Description
The SSM-1A (Type 88) missile is similar in appearance to ASM-1, with four delta-wings at mid-body and four moving delta control fins at the rear. The missile's overall length, including the jettisonable solid-propellant booster motor, is 5.08 m. The missile has a body diameter of 0.35 m, a wingspan of 1.02 m and weighs 660 kg. The High Explosive (HE) warhead weight is 225 kg and the sustainer motor is a TJM-2 turbojet giving SSM-1A a maximum range of 150 km. The missile is carried and fired from a Transporter-Erector-Launcher (TEL) vehicle, each vehicle has six cylindrical container-launcher canisters mounted in two layers of three. The SSM-1A can be launched up to 50 km from the coast at targets up to 100 km out to sea. Once fired, the missile adopts a terrain-following flight profile using an inertial guidance package until it clears the coastline, then it descends to a low altitude cruising height until the active radar seeker acquires the designated target. The missile finally adopts a sea-skimming profile using a radio altimeter for the terminal attack phase. The SSM-1A coastal defence missile system has up to four TEL vehicles, a fire-control vehicle, communications and surveillance radar vehicles.

It is reported that the ship-launched version SSM-1B (Type 90) missile is compatible with the RGM-84A Harpoon weapon system's launch and fire-control



An SSM-1B (Type 90) missile (Mitsubishi Heavy Industries) 0038253

SSM-1B coastal defence system communications and surveillance radar vehicles (Mitsubishi Heavy Industries) *0038256*

The launch of an SSM-1A (Type 88) missile from its TEL (Mitsubishi Heavy Industries) 0038254

An SSM-1B coastal defence fire-control vehicle (Mitsubishi Heavy Industries)
0038255

systems. The SSM-1B missile is 5.1 m long, just slightly longer than the SSM-1A. This version is powered by a TJM-3 turbojet, which has a weight of 45 kg and a thrust of 2 kN. All other dimensions, the launch weight and the range are the same as for the SSM-1A.

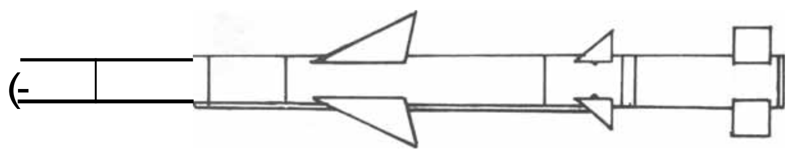
Operational status

SSM-1A, Type 88, is in production and entered service with the Japanese Ground Self-Defence Force in 1988. It is believed that a total of 580 SSM-1 missiles will be procured, with 80 TEL and associated surveillance, command and control vehicles. Four SSM-1A fire units were ordered in 1997, and four fire units in 2000. It is reported that there are five artillery regiments in Japan, each with 16 TEL. A coastal defence and ship-launched version, SSM-1B (Type 90), completed development in 1990 with ship-launched missiles being built from 1990 and with one coastal defence system, believed to total about 40 missiles and 4 TEL, ordered in 1994. It is believed that a common missile was developed for use with the SSM-1 and ASM-2 systems, designated Type 96, and that this missile entered service in 1997. Development of XSSM-2 started in 1994 and is expected to reach completion in 2002, and the system is expected to enter service in 2003.

Specifications

Length: 5.08 m (including boost motor) (SS-1A), 5.1 m (SSM-1B)
Body diameter: 0.35 m
Launch weight: 660 kg
Payload: Single warhead; 225 kg
Warhead: HE
Guidance: Inertial with active radar
Propulsion: Turbojet
Range: 150 km
Accuracy: n/k

A Traiisporter-Erector-Launcliei (TEL) vehicle with six Japanese SSM-1A missile canisters (M Ebata)



A line diagram of the SSM-1A (Type 88) missile

Contractor

Mitsubishi Heavy Industries, Nagoya Guidance and Propulsion Systems, Komaki.

ASM-1/-1C/ASM-2 (Type 80/Type 91/Type 93/Type 96)

Type

Short range, air-launched, solid-propellant/turbojet-powered, single warhead, air-to-surface missiles.

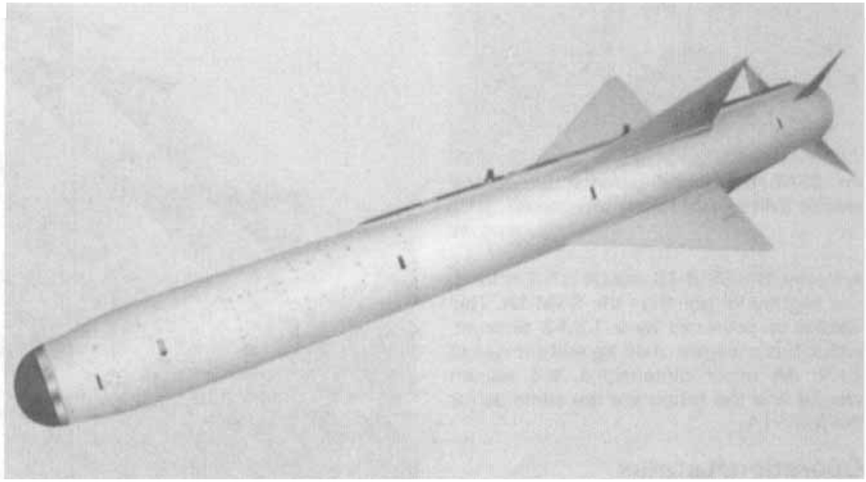
Development

The ASM-1 (designated Type 80) was Japan's first indigenous air-to-surface missile. The requirement was for an air-launched, anti-ship missile with an active radar terminal seeker, which would be the primary weapon for the Mitsubishi F-1 support aircraft. The development programme began in 1973, when Mitsubishi was awarded the development contract. The first test launch of two unguided ASM-1 missiles took place in 1977, the first guided launch in 1978 and the development phase of the programme was completed in 1980. Production of ASM-1 started in 1980 and the first prototype missiles were evaluated by the Japanese Air Self-Defence Force (JASDF) in 1981-82.

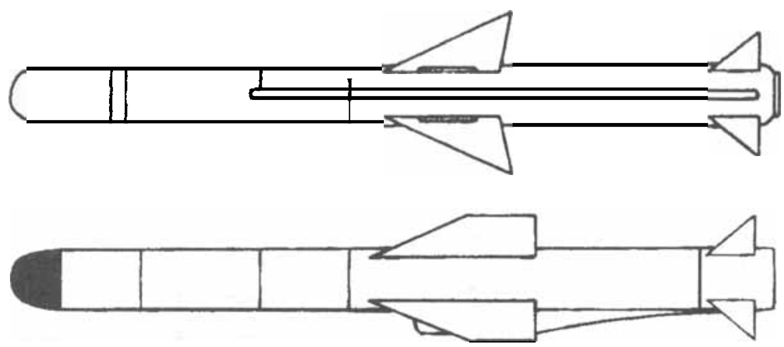
In 1981, the Japanese Defence Agency proposed the development of a new coastal defence system deploying a land-based version of the ASM-1, designated SSM-1 or Type 88 (for details of SSM-1 see separate entry). ASM-1 is believed to have entered service with the JASDF in 1983 and has been cleared for carriage on the F-1, F-4J Phantom and the P-3C Orion aircraft. It is believed that ASM-1 has also been cleared for carriage on the F-2 aircraft.

Studies into a longer-range version ASM-2 (or Type 93) began in the mid-1980s and entered full scale development in 1987. It is believed that ASM-2 utilises guidance and propulsion technology developed for the SSM-1 programme. Flight trials started in 1990 and 20 firings were completed by 1993. In 1989, it was reported that research was underway to develop a Fujitsu Imaging Infra-Red (IIR) terminal guidance system for the ASM-1. Such a system would be less prone to Electronic CounterMeasures (ECM) and would also guide the missile to strike at a target's vulnerable point, the engine room. However, the IIR seeker programme was incorporated into the ASM-2 missile, which started in initial production in 1993. It is believed that ASM-2 missiles have been cleared for carriage on F-1, F-2, P-3C Orion and F-15J Eagle aircraft.

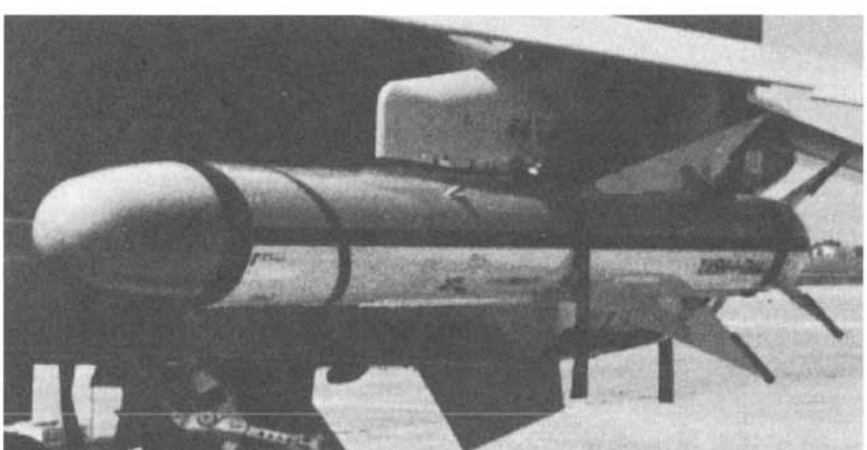
In 1994, it was revealed that between 1986 and 1990 an ASM-1 version, designation ASM-1C (or Type 91), had been developed for the JASDF P-3C Orion maritime patrol aircraft. This version is reported to be 90 kg lighter than ASM-1, and to have a greater range. It is believed that an upgraded ASM-2 version, designated Type 96, was developed as a common air- and ground-launched missile.



An ASM-2 (Type 93) missile (Mitsubishi Heavy Industries) 0038257



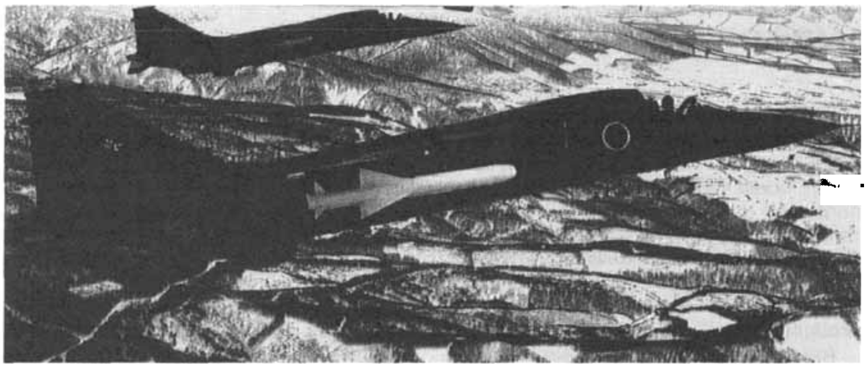
Line diagrams of the ASM-1 (Type 80) missile (top) and the ASM-2 (Type 93) missile (bottom) 0054290



An early production ASM-1 missile fitted to JASDF Mitsubishi F-1 aircraft during firing trials in 1977

Description

The ASM-1 (Type 80) missile is a short-range, radar-guided, air-to-surface missile powered by a solid-propellant motor and armed with a High Explosive (HE) Semi-Armour-Piercing (SAP) warhead. It is cylindrical in shape with a rounded nose, has four sharply swept delta-wings just aft of mid-body and four moving delta control fins at the rear. The missile is of modular construction and is made up of four major sections. A nose-section consisting of the rounded radome, which covers the seeker's antenna and the active radar seeker. A warhead section, which contains the warhead, initiator and warhead safety and arming device. A propulsion section that contains a Nissan solid-propellant rocket motor, and a tail section, which is situated around the motor exhaust and is believed to contain the inertial guidance system, radio altimeter, power supplies and control fin actuators. The ASM-1 missile is 4.0 m long, has a body diameter of 0.34 m, a wingspan of 1.02 m and a launch weight of 600 kg. It is fitted with a 150 kg SAP warhead, which is probably detonated by a delayed-action impact fuze.



An ASM-1 training missile fitted to a JASDF F-1 aircraft

The warhead would have been optimised to penetrate and explode inside ship hulls for maximum effectiveness. Guidance in mid-course is inertial with the radar altimeter controlling the cruise height. Once a target is detected and identified by the launch aircraft's radar, target range and bearing are fed into the missile's navigation system. On release the missile descends to its sea-skimming altitude and, at a predetermined distance from the target, the active radar seeker head is activated and commences scanning. After lock-on has been achieved the inertial guidance is slaved and corrected in azimuth and range by the seeker head and the missile is guided to impact. ASM-1 has a cruise speed of about M0.9 and maximum effective range of 50 km. It must be launched at speeds greater than M0.6 and is normally launched at low level.

The ASM-1C (Type 91) missile is similar to the ASM-1. It has a length of 4.0 m, a body diameter of 0.35 m, a wingspan of 0.9 m, and a launch weight of 510 kg. The missile has a maximum range increased to 65 km when released from medium altitude (30,000 ft).

Unconfirmed reports on the ASM-2 (Type 93) missile indicate a turbojet-powered missile with a range of 100 km. The missile is believed to have a length of 4.1 m, a diameter of 0.35 m, a wingspan of 0.9 m, and a launch weight of 520 kg. It is not known if this missile uses the 150 kg HE SAP warhead from ASM-1C or the larger 225 kg warhead from the SSM-1 missile. Mid-course guidance is reported to be inertial with updates and an IIR seeker developed by Fujitsu is used for terminal guidance. A passive radar homing version has also been mentioned together with composite wings to reduce the radar cross-section. It is not known what specific improvements have been made to the Type 96 missiles.

Operational status

ASM-1 (Type 80) missile production started in 1980 and entered service with the JASDF in 1983. Low-rate production continues at a rate believed to be between 20 and 30 missiles per year. Export sales of ASM-1 are not expected since the programme, as is common with Japanese indigenous programmes, will probably be produced only to meet the requirements of the Japanese defence forces. ASM-1C (Type 91) production started in 1991 and the first missiles entered service in 1992.

Development of ASM-2 (Type 93) is complete with 20 flight trials made between 1990 and 1993 and early production started in 1993. In service evaluation trials have been reported in 1996/97 and in 1998, tests were being made on the F-2 aircraft. Some problems were reported when four missiles were carried on the F-2, but it is believed that these have now been rectified. The Type 96 missile version is believed to have entered service in 1997.

Specifications

ASM-1/-1C
Length: 4.0 m
Body diameter: 0.34 m (ASM-1), 0.35 m (ASM-1C)
Launch weight: 600 kg (ASM-1). 510 kg (ASM-1C)
Payload: Single warhead
Warhead: 150 kg HE SAP
Guidance: Inertial and active radar
Propulsion: Solid propellant
Range: 50 km (ASM-1). 65 km (ASM-1C)
Accuracy: n/k

ASM-2
Length: 4.1 m
Body diameter: 0.35 m
Launch weight: 520 kg
Payload: Single warhead
Warhead: 150 or 225 kg HE SAP
Guidance: Inertial, updates and IIR
Propulsion: Turbojet
Range: 100 km
Accuracy: n/k

Contractor

Mitsubishi Heavy Industries, Nagoya Guidance and Propulsion Svstems, Komaki (prime contractor)

'SCUD B' variant (Hwasong 5)

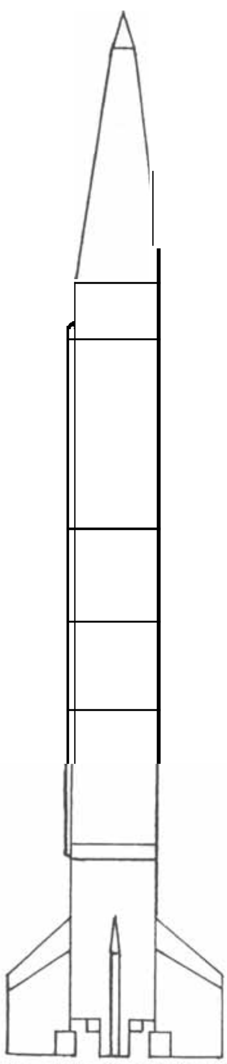
Type
Short-range, road mobile, liquid-propellant, single warhead ballistic missile.

Development
It is believed that Egypt sent a small number of Russian built SS-1 'Scud B' missiles and TELs to North Korea in 1981 for reverse engineering. In 1983 an agreement was signed between North Korea and Iran for the purchase of a number of new missiles and to set-up a manufacturing capability for the 'Scud B' variant in Iran. Flight tests of the new missile began in 1984, when it is reported that seven flights were attempted, with three successful. The North Korean 'Scud B' variant is believed to be called Hwasong 5. It is believed that the initial batch of missiles was identical to the original Russian design, but that from 1985 improvements were introduced particularly in the airframe, guidance and motor designs. The Russian MAZ 543 TEL was copied as well. A production facility was built in North Korea, at No 125 Factory at Mt Hyongje near Pyongyang, with initial production starting there in 1985. Full-scale production, at around 50 missiles per year, was reached in 1987. 'Scud B' variant missiles were deployed in North Korea from 1986 and production continued until 1991 when it is believed that the facilities were converted to 'Scud C' variant production. However, reports of later exports suggest that the facility at No 125 Factory retained the capability to produce 'Scud B' variant missiles.

Assembly of the North Korean 'Scud B' variant started at Isfahan in Iran in 1988, probably with just the final assembly and test of components built in North Korea, but later converting to the manufacture of complete missiles. Assistance was given by North Korea to Egypt in 1989 to help the Egyptians develop an improved Scud B version, known in Egypt as Project T, and this version was manufactured in Egypt from 1990 to 1995 US reports in 2001 suggested that North Korea or Iran tested a 'Scud B' variant missile from the deck of a ship, using a standard TEL vehicle, around 1998 or 1999.

Description
The 'Scud B' variant has a length of 10 9 m, a body diameter of 0.88 m and a launch weight of 5,840 kg The missile has four fixed clipped-tip delta wings at the rear and is controlled during the boost phase of flight by four graphite vanes located below the wings in the exhaust efflux The warhead assembly, located at the nose, remains attached to the motor and propellant tank assemblies throughout the flight The liquid propellants are UDMH fuel and IRFNA oxidant, with a total weight of 3,130 kg. The burn time is around 60 seconds and the missile will have reached an altitude of around 30 km at boost termination. The fuel and oxidant tanks are pressurised by compressed air and then fed to a single combustion chamber. Before launch the missile is set-up with pre-computed corrections for wind velocity and direction, it has a rudimentary inertial system with three gyroscopes for guidance during the boost phase. The warhead section has a length of 2.87 m and a total weight of 985 kg. It is possible that North Korea has developed several warhead types, which are reported to include unitary HE, unitary chemical, biological and chemical submunition types The minimum range of the 'Scud B' variant is 70 km and the maximum range 300 km, although there is a report which states the maximum range is 320 km. The accuracy is believed to be 450 m CEP, although one report suggests 800 to 1,000 m CEP.

The missiles can be carried on Russian designed MAZ 543 TELs and it is believed that some were reverse engineered and made in North Korea. In addition, several commercial articulated trucks have been converted by countries for use as TELs for



Line diagram of the 'Scud B' variant missile
0054288

A Russian-built MAZ 543 TEL with a 'Scud B' missile in the road transport position (Robert Fleming)
0054289

the 'Scud B' class of ballistic missiles, and there is every possibility that North Korea has done the same. The MAZ 543 TEL has a length of 13.36 m, a width of 3.02 m and a weight of 37,400 kg when loaded with a missile. This TEL has eight wheels and is powered by a 525 hp diesel engine with all four axles driven. There is a separate 10 kW electrical generator to power the missile operations and two hydraulic pumps to raise the missile to the vertical position before launch. The TEL vehicle is supported by four hydraulic jacks during the missile launch. The TEL has a maximum road speed of 55 km/h and an un-refueled range of 650 km. Providing that the launch site has been pre-surveyed then the launch sequence takes around one hour, which includes filling the missile with fuel and oxidant and setting-up the launch and target parameters. The TEL vehicle can be moved away about five minutes after the launch. A complete 'Scud B' variant firing battery would normally comprise four TELs with around 12 supporting vehicles.

Operational status

The first flight test of the North Korean 'Scud B' variant, Hwasong 5, was made in 1984 and it is reported that seven flight tests were made with only three successful. Early production started in 1985 and the missiles entered service in 1986. Production continued until 1991/92, with an estimated 300 missiles built. It is believed that around 180 remain in North Korea and that 120 were exported to Iran with about 18 to 20 TELs. The 'Scud B' variants are believed to be located at Singye (Hwanghae-Pukto province), Sarium (Hwanghae-Namdo province) and Okpyong (Kangwan-Do province).

Unconfirmed reports suggest that these missiles were exported to Republic of Congo, Cuba, Egypt, Ethiopia, Iran, Iraq, Libya, Syria, UAE and Vietnam, but as the 'Scud B' and 'Scud C' variants are virtually identical there is probably some confusion. The export to Cuba has never been confirmed, and it is possible that only technologies were exported to Egypt and Libya. Iraq requested the export of 'Scud B' variant missiles in 1990, but it is believed that this was cancelled in early 1991. An agreement was made with Iran in June 1987 to export 90 to 100 missiles, and to help Iran to set-up an assembly and test facility. Iran launched 77 'Scud B' variant missiles against Iraq in 1988, and then started to build what became known in Iran as Shahab 1 missiles from about 1989. It is not clear if Syria bought any 'Scud B' variant missiles from North Korea, but it is possible that a small number were bought with the 'Scud C' variants. The UAE bought 25 missiles in 1989, and it is reported that these missiles have remained in storage ever since. Some missiles were exported to Vietnam in 1998, and it is believed that these were probably all 'Scud C' variants.

Unconfirmed reports in 1999 suggested that North Korea had sold some 'Scud B' variant missiles to Ethiopia, and that possibly Iran or North Korea had sold some missiles to the Republic of Congo.

Specifications

Length: 10.9 m
Body diameter: 0.88 m
Launch weight: 5,840 kg
Payload: Single warhead
Warhead: 985 kg HE, chemical or submunitions
Guidance: Inertial
Propulsion: Single-stage liquid propellant
Range: 300 km
Accuracy: 450 m CEP

Contractor

It is believed that the prime contractor was the Fourth Machine Industry Bureau, Pyongyang. The missiles were made at the No 125 Factory at Mt Hyongje near Pyongyang, and the motors and fuel tanks were made at the January 18th Machinery Factory, Kanggye.

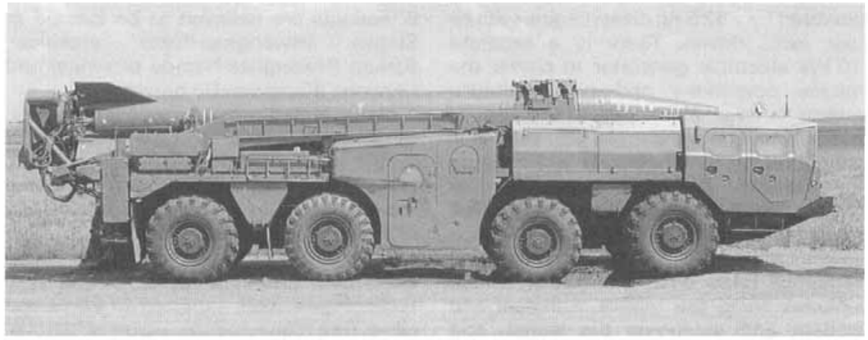
'SCUD C' variant (Hwasong 6) and 'SCUD D' variant (Hwasong 7)

Type

Intermediate-range, road mobile, liquid-propellant, single warhead ballistic missile.

Development

It is believed that the development of the 'Scud C' variant, Hwasong 6, was started in North Korea by the Fourth Machine Industry Bureau in 1984, following on from the successful reverse engineering and improvement of the SS-1 'Scud B' missiles received from Egypt. The origins of the design for increasing the 300 km range of the 'Scud B' to 500 km for the 'Scud C variant are not known, but could have come from earlier Russian designs or from the Chinese. It is interesting to compare the approach taken by the North Koreans with that taken two or three years later by Iraq. Whereas the Iraqi design was similar, in that the fuel and oxidant tanks were enlarged and the warhead weight decreased, the workmanship in the North Korean case was superior as they fully modernised the airframe using lighter steel skins. The Iraqi design, known as Al Hussein, increased the length of the basic 'Scud B' airframe from 11.25 m to 12.46 m, by welding in a body plug from a cannibalised missile section. The North Korean variant retains the original 'Scud B' variant (10.9 m length), but carries more fuel by redesigning the fuel and oxidant tank shapes. A reverse engineered Russian MAZ 543 Transporter-Erector-Launcher (TEL) vehicle was also developed in North Korea, to carry both the 'Scud B' and 'Scud C' variants. A series of test launches was made between 1987 and 1990. The first reported full range launch test of the North Korean 'Scud C variant was in October 1991 and full-scale production started in 1992.



A Russian MAZ 543 TEL. with a 'Scud' missile in the road transport position. The North Korean 'Scud C' variant will be similar (Robert Fleming) 0022174

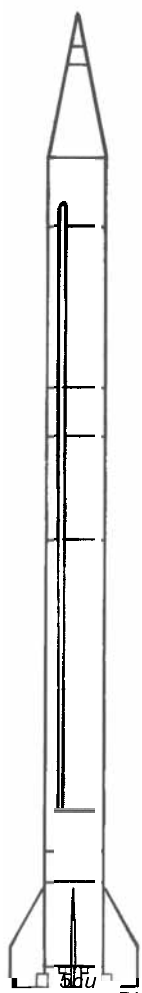
Unconfirmed reports in 1997 suggested that a longer range version of the 'Scud C' variant had been developed in the early 1990s. and this was confirmed in 2000 when a missile was flight tested in Syria. It is believed that this is known as the 'Scud D' variant, Hwasong 7, with the payload reduced and the range increased to 700 km. This variant bears no resemblance to the former Soviet SS-1 'Scud D' design, which was a much more accurate missile with a range of 300 km, but did not enter service.

Description

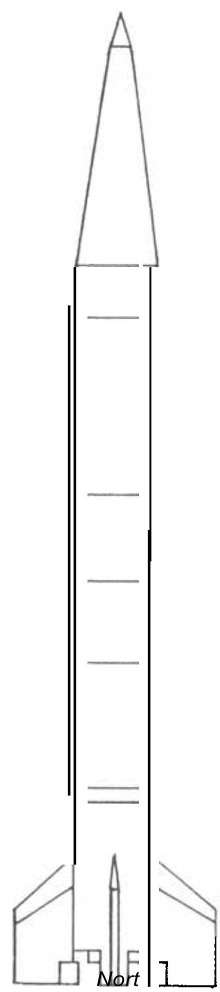
The 'Scud C' variant developed by North Korea has a length of 10.9 m, a body diameter of 0.88 m and a launch weight of 6,200 kg. The payload is believed to be 700 kg, with a redesigned warhead assembly that can carry unitary HE, unitary chemical, biological, chemical submunition or HE submunition types. It is not known if the warhead assembly separates from the motor section after motor burnout, as in the Russian design. The fuel and oxidant tanks have been enlarged, with a total propellant weight believed to be 4,500 kg. The propellants are believed to be UDMH and IRFNA, and the total burn time is around 72 seconds. It is believed that the inertial guidance system from 'Scud B' has been upgraded and that the 'Scud C' variant has an accuracy of 1,000 m CEP. Control during the boost phase is carried out by graphite vanes in the motor exhaust. The minimum range is probably around 100 km and the maximum range is 500 km.

The North Koreans have several types of TEL vehicles in use, including the reverse engineered Russian MAZ 543 associated with the 'Scud B' variant, MAN and Nissan converted tractor and trailer vehicles.

The 'Scud D' variant appears to have been developed by lengthening the main body section to carry more fuel and oxidant, whilst reducing the payload. This variant has a length of 13.5 m, a body diameter of 0.88 m, and a launch weight of 6,400 kg. The payload is believed to have been reduced to 500 kg, and the warhead is expected to be unitary HE, chemical or submunitions. The warhead assembly



A line diagram o Scu D' variant missile NEW/0143187



A line diagram o Nort Korean 'Scud C' variant missile 0054288

separates after motor burn-out, which is believed to occur at around 80 seconds after launch. The total propellant weight is probably around 4,950 kg. The minimum range is probably 150 km, and the maximum range 700 km. The accuracy at maximum range is believed to be around 3,000 m CEP.

Operational status

Development of the 'Scud C' variant (Hwasong 6) started in North Korea in 1984, and production started in 1991/92 at the former 'Scud B' facility near Pyongyang, but was later transferred to a large underground facility at Kanggye in Chagang-Do province. It is believed that North Korea was producing from 50 to 100 'Scud B' and 'Scud C' variant missiles per year during the late 1980s and early 1990s with several upgrades being incorporated in the later built missiles. Production has now been slowed and has probably ceased, except for specific export orders. Around 200 'Scud C' variant missiles are believed to be in service in North Korea with 50 TEL or fixed launch sites. These missiles are believed to be located at four main sites; Singye in Hwanghae-Pukto province, Sariwan in Hwanghae-Namdo province, Okpyang in Kangwon-Do province and at Chunggang in Chagang-Do province. Each missile regiment has four battalions, and each battalion has six TELs and around 175 men. It is possible that some 400 'Scud B' and 'Scud C' variant missiles were exported by North Korea to Cuba, Egypt, Iran, Iraq, Libya, Syria and Vietnam. However, there is no confirmation that Cuba, Egypt, Iraq or Libya received 'Scud C' variants, and the numbers are difficult to determine as Iran and Syria are assembling missiles and have set up their own production lines. It is reported that 60 missiles were exported to Iran in 1991, and that Iran made a flight test in May 1991. Iran then started to assemble and test and eventually to build its own missiles, which are known as Shahab 2 missiles. Around 60 missiles and 12 TEL were exported to Syria starting from 1991, who then set up assembly and test and later production facilities with the help of Iran. Three missiles were tested in Syria between 1992 and 1994, and a further four missiles were tested in 1997. Further flight tests were made in 2000 and 2001. It is believed that 'Scud C' variant technologies were sold to Egypt and Libya, and an unconfirmed report suggested that Egypt may assemble or build 'Scud C' variant missiles from 2001/2002. Vietnam is reported to have ordered some 'Scud C' variant missiles from North Korea in 1998, and an offer was made to Sudan in 1999 to set up a manufacturing facility for 'Scud B' or 'Scud C variant missiles probably in co-operation with Iran. Iraq is reported to have been interested in purchasing 'Scud C' variant missiles in 2001, with a suggested total of 200 missiles for delivery by 2005.

Development of the 'Scud D' variant is believed to have started in 1991, with a first flight test in North Korea in 1993. It is possible that this first flight test was mistaken as a 'Scud C' variant. The North Koreans may have built some 'Scud D' variant missiles from 1994 for their own use, but there have been no reports to confirm this. A flight test from Syria in September 2000, indicated that some 'Scud D' variant missiles had been exported to Syria, or perhaps that Syria had built some missiles from parts supplied by North Korea. The benefit for Syria is that the increased range enables the whole of Israel to be targeted, and these missiles would also reach Ankara, Turkey. It is believed that Syria has converted its 'Scud C' variant production line to build 'Scud D' variants, and is building between 15 and 30 missiles per year. The Syrian missiles are stored in tunnels and caves.

Specifications

'Scud **C'** variant
Length: 10.9 m
Body diameter: 0.88 m
Launch weight: 6,200 kg
Payload: Single warhead 700 kg
Warhead: Chemical, HE or submunitions
Guidance: Inertial
Propulsion: Single-stage liquid propellant
Range: 500 km
Accuracy: 1,000 m CEP

'Scud **D'** variant
Length: 13.5 m
Body diameter: 0.88 m
Launch weight: 6,400 kg
Payload: Single warhead 500 kg
Warhead: Chemical, HE or submunitions
Guidance: Inertial
Propulsion: Single-stage liquid propellant
Range: 700 km
Accuracy: 3,000 m CEP

Contractor

It is believed that the prime contractor is the Fourth Machine Industry Bureau, Pyongyang and that the missiles are produced at the underground facility at the No 26 General Plant, Kanggye, Chagang-Do.

No-dong 1/2

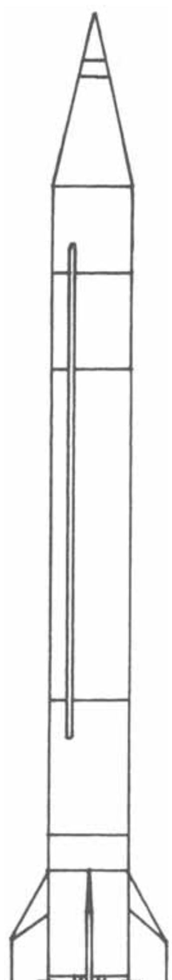
Type
Intermediate-range, ground mobile, liquid-propellant, single warhead, ballistic missiles.

Development
North Korea began to build SS-1 'Scud B' variant liquid-propellant ballistic missiles in the mid-1980s. and then extended their range with the 'Scud C' and 'Scud D' variants. It is believed that design work on the No-dong 1 started at the Fourth Machine Industry Bureau in 1984. It is not clear if the Chinese assisted North Korea directly; it seems possible that the North Koreans used earlier collaboration with China on a project known as Dong Feng-61 as the basis for the No-dong 1 approach. The No-dong 1 design appears to be a scaled-up version of the 'Scud C' variant, with the same length/diameter ratio, and the motor was a scaled-up version of the Russian Isayev 9D21 from the 'Scud B', 'Scud C' and 'Scud D' variants. The former Soviet Union scaled-up their SS-1 'Scud B' design as the basis for the R-5 (SS-3 'Shyster') missile, which was first flight tested in 1952. This design was passed to China in 1958, and the Chinese built the DF-2 (CSS-3)which was first flight tested in 1964. The R-21 (SS-N-5 'Sark) was probably used as a design base for the No-dong as well as the R-5 missile, and there are many reports of former Russian and Chinese missile engineers assisting the North Korean missile programmes. No-dong 1 trial launches have been reported, with between four and five attempted from May 1990 to May 1993, although at least two are reported as unsuccessful or failed launches. Two successful test flights were made in August 1991 and May 1993, the latter across the Sea of Japan, to a range of just over 500 km. It is estimated that development was completed in 1994 and that low-rate initial production started at the No 26 General Plant in Kanggye in 1994/1995.

A further development, known as No-dong 2, has been reported since 1992, which may have a smaller warhead and an increased range. The precise differences between the No-dong 1 and 2 missiles are not known, but it is believed that the No-dong 2 has an improved guidance system. It is also believed that the improved No-dong 2 version was the design used by the North Koreans as the basis for the two further missile programmes, provided to Pakistan for its Ghauri 1 (Hatf 5) missile and to Iran for its Shahab 3 missile. It is possible that these two designs were specifically modified by the North Koreans to meet two separate requirements. It is clear that from around 1989 both Iran and Pakistan joined with North Korea on the No-dong development programme, and there have been representatives from all three countries at each of the test flights for the three missile types.

The No-dong 2 missile motor assembly is also used as the first stage for the North Korean Taep'o-dong 1 ballistic missile or satellite launch vehicle, which was first launched in August 1998.

Description
The North Koreans have given few details about any of their ballistic missiles, and the following description is based upon information deduced from a comparison of Pakistan's Ghauri and Iran's Shahab 3 missiles. The No-dong 1 missile is believed to be 16.0 m long, to have a body diameter of 1.32 m and a launch weight of 16,250 kg. The shape of No-dong 1 is believed to be similar to that of the Russian SS-1 'Scud B' design, but considerably larger, although retaining a similar length/ diameter ratio. The missile is believed to have a single-stage liquid propellant system, using Unsymmetrical Dimethyl Hydrazine (UDMH) and probably Inhibited Red Fuming Nitric Acid (IRFNA)or nitrogen tetroxide. The total fuel and oxidant are believed to weigh 12,200 kg, and reports suggest that a scaled-up 'Scud B'-type motor was used, resulting in a 100 second burn time. No-dong 1 is thought to have inertial guidance with graphite vanes reacting on the motor exhaust to control the missile during the boost phase, similar to 'Scud B'. The control vanes are operated by compressed air, and compressed air is also used to pressurise the fuel and oxidant tanks. The accuracy is estimated to be 2,500 m CEP at maximum range. The payload is believed to be 1,200 kg, with the warhead section separating from the missile shortly before re-entry to the atmosphere. It is thought there is a wide range of warhead options available, with weights around 800 kg, which could include nuclear, chemical, biological, unitary High Explosive (HE), chemical submunitions or HE submunitions. A report in 1995 suggested that 5 kg submunitions would be carried by the No-dong 1, with about 100 submunitions in each warhead assembly. The minimum range of No-dong 1 is believed to be 400 km, and the maximum range 1,300 km, but no test flights in North Korea have exceeded 500 km.



A line diagram of a No-dong 1 ballistic missile

North Korea is believed to have converted the Russian-designed SS-1 'Scud B' Transporter-Erector-Launcher (TEL), the MAZ 543, to carry the No-dong 1 missile, by including an additional one or two axles and increasing the TELs length to 17 m and the loaded weight to 60,000 kg. North Korea has also converted other commercial articulated trucks to TELs for the 'Scud B', 'Scud C' and 'Scud D' variant missiles, and may have lengthened these to carry the No-dong 1. It is also likely that North Korea has converted tank transporter vehicles for use as TELs, following their use by Iran and Pakistan.

No-dong 2 is reported to be a longer range version of No-dong 1, using a single stage motor assembly and an improved structure. However, the precise differences between the two versions are unclear, particularly since the launch of the Pakistan Ghauri 1 (Hatf 5) and Iranian Shahab 3, which has resulted in several conflicting reports on the missile specifications. It is believed that No-dong 2 has a maximum range increased to 1,500 km, and that it may have an improved guidance system, resulting in an accuracy of 250 m CEP. The range increase may have been achieved by reducing the payload, and by a lighter warhead structure.

Operational status
The first test firing of a No-dong 1 missile was reported in May 1990 from the Hwadae-gun flight test centre near Musudan-ri, and is believed to have been unsuccessful. A second successful test was made in August 1991, but a third test in June 1992 was unsuccessful. Reports conflict as to whether one or two No-dong 1 missiles were launched in May 1993, with ranges of about 500 km, but it is believed that only one No-dong was launched. Initial low-rate production is believed to have started in 1994, at the large underground facility No 26 General Plant in Kanggye. It is believed that No-dong 1 entered service in North Korea in 1994.

Reports from the USA have suggested that launch preparations were made in May 1994, October 1996 and October 1997 for test flights of No-dong missiles, but no launches were reported. There were also reports that Iran entered into a joint development programme for No-dong 1

and 2 with North Korea, with Iran receiving 150 missiles and that a test range in Iran would be used for full range trials; these reports have been denied by both Iran and North Korea. However, the development of the Shahab 3 missile in Iran appears to be similar in size and shape to the No-dong 2, and may share similar components or technologies. The first launch of Shahab 3 was made in July 1998, with subsequent tests in July 2000, September 2000, and May 2002. Pakistan's first launch of its Hatf 5 (Ghauri 1) missile was made in April 1998, with a larger Ghauri 2 tested in April 1999, and a Ghauri 1 in May 2002. Ghauri 1/2 missiles are similar in size and shape to No-dong 2, suggesting that North Korea also supplied No-dong components or technologies to Pakistan. There are also unconfirmed reports that Egypt, Libya and Syria have negotiated to purchase No-dong missiles, and that some No-dong technologies have been passed to these countries, with increased contacts between North Korea and Libya since 1998. A report in 2000 suggested that Libya has ordered 50 missiles and 7 TELs, but this may have been confusing motors and components with complete missiles. An unconfirmed report in September 2001 suggested that Egypt had ordered assemblies and components to build up to 50 No-dong type missiles.

In December 1994, reports indicated that six TELs and between 12 and 18 No-dong 1 missiles were in service in North Korea and that full-scale production would start during 1996 with between 10 and 25 missiles a year being built. It is possible that some of this production has been used to supply components to Iran and Pakistan, with some 20 to 45 assemblies or missiles supplied between 1994 and 2002. By 1999 it was estimated that some 50 to 100 missiles and 15 to 20 TELs have been built for operational use in North Korea, with battalions located at four sites, each battalion with six TELs. Each site is believed to have underground facilities for missile storage and preparation. The sites are believed to be Mayang-do in Hamgyang-Namdo province, Myongchon in Hamgyang-Pukto province, Chunggang in Chagang-Do province and Okpyang in Kangwan-Do province. North Korean engineers have been present at the launches of the Ghauri 1 and 2 missiles in Pakistan and at the Shahab 3 launches in Iran. In exchange, Pakistani and Iranian engineers have been present at the No-dong and Taep'o-dong launches in North Korea. It should probably be assumed that these programmes are being co-ordinated and that the telemetry and test results might be shared.

Specifications

No-dong 1/2
Length: 16.0 m
Body diameter: 1.32 m
Launch weight: 16,250 kg
Payload: Single warhead 1,200 kg
Warhead: 800 kg, nuclear, chemical, HE or submunitions
Guidance: Inertial
Propulsion: Single-stage liquid propellant
Range: 1,300 km (1) or 1,500 km (2)
Accuracy: 2,500 m CEP (1), or 250 m CEP (2)

Contractor

The prime contractor is believed to be the Fourth Machine Industry Bureau, Pyongyang, with the missiles made at the underground facility at the No 26 General Plant, Kanggye.

Taep'o-dong 1

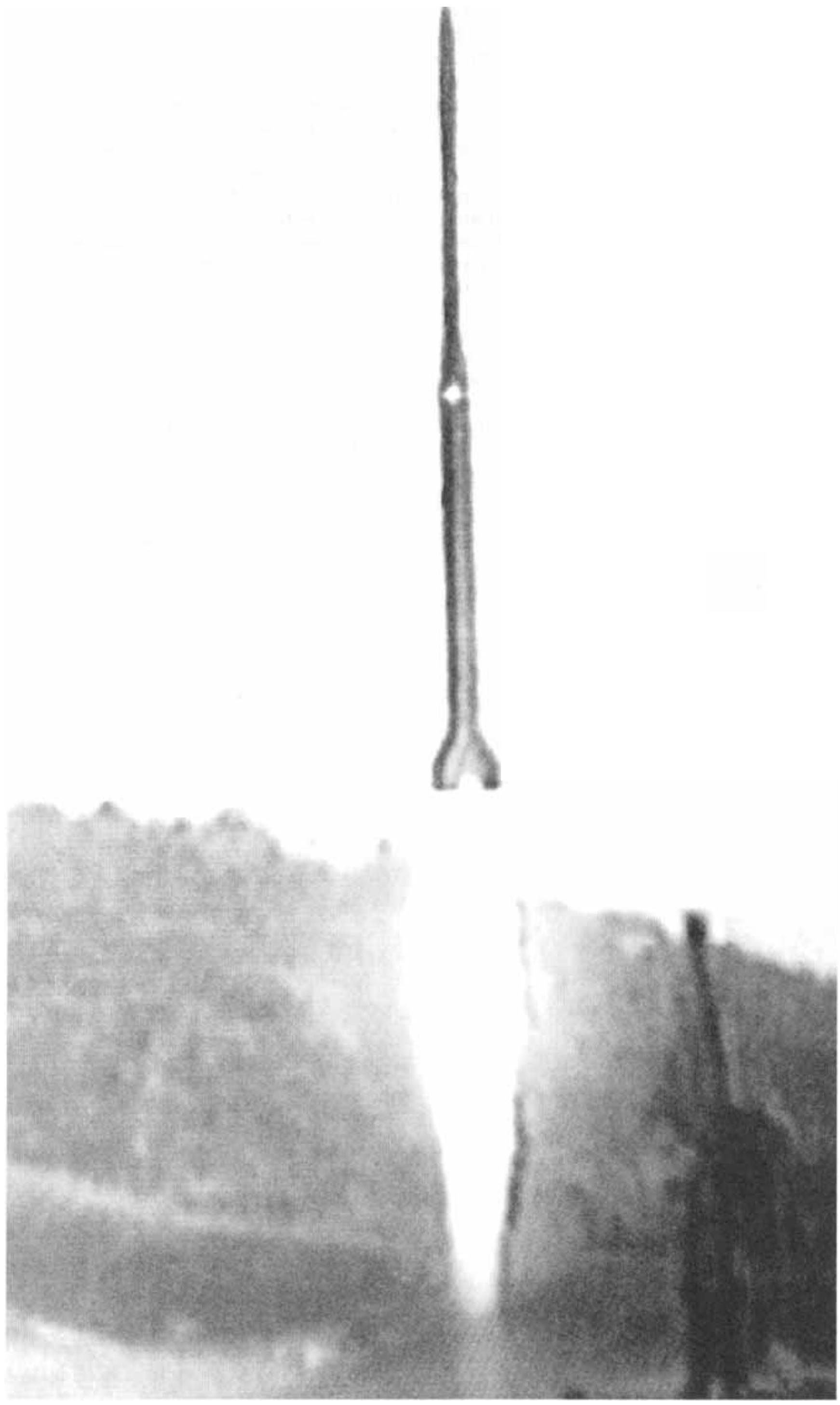
Type

Intermediate range, liquid- and solid-propellant, single warhead ballistic missiles.

Development

It is believed that the design of a two-stage liquid-propellant ballistic missile started in North Korea in 1990, possibly with the name Moksong 1 or Pekdosan 1, although these names have not been confirmed. It is believed that a decision was taken in 1993 to use the missile for launching satellites as well, following the successful launch of a second satellite by South Korea. It is also possible that a joint satellite launch vehicle and ballistic missile development programme was agreed between North Korea, Pakistan and Iran in 1993. Two missile mock-ups were photographed by the USA in 1994, and these were given the US names Taep'o-dong 1 and Taep'o-dong 2, as the nearest map reference was called Taep'o-dong. The first of these, Taep'o-dong 1, was believed to use a No-dong first stage and a 'Scud B or C variant second stage. The second missile, Taep'o-dong 2, used a new first stage with a No-dong second stage. The missile mock-ups were seen in 1994 at the Sanum-dong missile research and development facility; a test firing of the first-stage motor was seen in May 1994 and then the mock-ups were concealed. In 1997 an underground assembly and test facility for the Taep'o-dong 1 missile was reported at Hwadae-gun, with a second underground facility at Doksong in Hamgyong-Namdo province. The North Koreans have used decoy missiles and facilities as well as underground storage areas to confuse satellite and aircraft surveillance systems, and it has been difficult to interpret what has been seen.

The first test launch of the Taep'o-dong 1 was made in August 1998, although this test used a three stage missile with an additional solid-propellant third stage added. The launch was made from the Hwadae-gun test facility near Musudan-ri and it is reported that the third stage flew for around 4,000 km. The test site had a single open mesh square launch platform, with a height of about 40 m. Preparations were reported for a second test launch in November 1998, but no further test flights have been made. There have been unconfirmed reports that the guidance system has been improved in 1999, possibly with some assistance from Chinese technicians. North Korea described the launch in 1998 as a satellite launch vehicle test, stating that the third stage placed a small satellite into an elliptical orbit. US and other reports suggested that the satellite did not go into orbit as the third stage failed during motor burn. A first stage motor test was reported in June 2001, with the first stage mounted horizontally on the ground. Several new structures were seen at the Hwadae-gun test site, although North Korea had agreed to a moratorium on test flights until 2003.



***The August 1998** launch of a Taep'o-dong 1* (SLV) (PA News) 0054287

Description

There would seem to be two possible versions of the Taep'o-dong 1 missile; a two-stage version and a three-stage version. The three-stage version could also be used as a satellite launch vehicle. The two-stage version is described as the Taep'o-dong 1 and the threestage version as Taep'o-dong 1 (SLV).

Taep'o-dong 1 has a length of 27.0 m and a launch weight of 21,700 kg. The first stage is based on a No-dong missile with a length reduced to 14.3 m and a body diameter of 1.32 m. The first stage probably has 12,200 kg of kerosene and IRFNA liquid propellants, with a single motor that burns for 95 seconds and a total first stage weight of 14,800 kg. The missile is controlled during the first stage burn by four graphite vanes located in the exhaust efflux of the motor. A short interstage assembly joins the first and second stages,

Specifications

	TD 1	TD 1 (SLV)
Length	27.0 m	32.0 m
Body diameter	1.32 m/0.88 m	1.32 m/0.88 m
Launch weight	21,700 kg	25,700 kg
Payload	Single warhead	Single warhead
Warhead	750 kg nuclear, biological, chemical or HE	750 kg nuclear, biological, chemical, or HE
Guidance	Inertial	Inertial
Propulsion	Two-stage liquid	Three stage; two liquid, one solid
Range	2,000 km	5,000 km
Accuracy	3,000 m CEP	4,000 m CEP

with a length of 1.45 m. The second stage is based upon the 'Scud C' variant (Hwasong 6) missile, with a length of 9.35 m and a body diameter of 0.88 m. This stage is believed to have 4,500 kg of UDMH and IRFNA liquid propellants, with a single motor that burns for between 90 and 170 seconds. The second stage weight is 5,630 kg. The payload assembly has a length of 1.9 m and a weight of 1,000 kg, it is believed that the warhead weighs around 750 kg. The first and second stages are jettisoned after use, leaving the payload assembly to continue to the target. It is assumed that the payload assembly is similar to that developed for the 'Scud C' variant missile, with nuclear, chemical, biological or HE warhead options. Guidance is inertial during the boost phases, but there is no known mid-course or terminal guidance. The minimum range of Taep'o-dong 1 is believed to be 500 km, with a maximum range of 2,000 km. The accuracy is expected to be 3,000 m CEP. The maximum range could be increased by reducing the payload, for example, a 400 kg payload might have a range increased to 3,000 km.

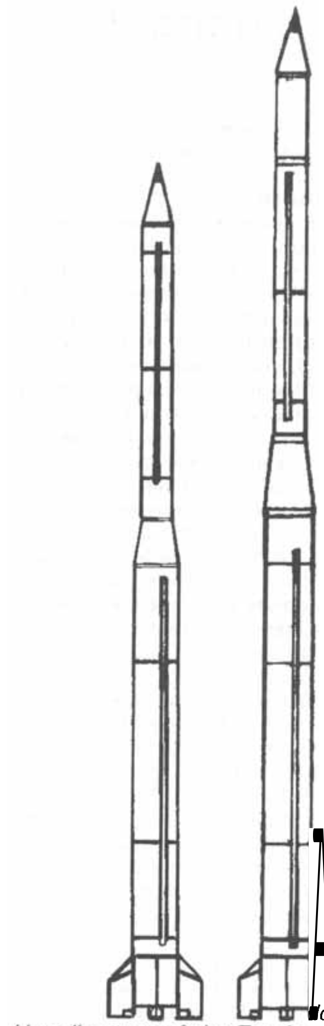
Taep'o-dong 1 (SLV) has a length of 32.0 m and a launch weight of 25,700 kg. The first stage is based on the No-dong missile, but has a length of 16.0 m and a body diameter of 1.32 m. The first stage carries 13,870 kg of kerosene and IRFNA liquid propellants and has a total weight of 16,870 kg. This stage has a single motor with a burn time of around 105 seconds, with control from four graphite vanes in the motor efflux. A 2.3 m long interstage assembly joins the first and second stages. The second stage is based upon the 'Scud C' variant missile, with a length of 9.35 m, a body diameter of 0.88 m and a weight of 5,630 kg. The single motor has a burn time between 90 and 170 seconds. There is a short interstage between the second and third stages, with a length of 0.4 m. The third stage has a length of 2.05 m, a body diameter of 0.88 m and a weight of 1,600 kg. This stage has a solid-propellant motor with a burn time of around 25 seconds. Attached to the third stage is the payload assembly, which has a length of 1.9 m and a weight of 1,000 kg, with a warhead weight of 750 kg. It is assumed that the payload assembly is similar to that developed for the 'Scud C' variant missile, with nuclear, biological, chemical or HE warhead options. Guidance during the boost phases is inertial, but there is no known mid-course or terminal guidance. This version probably has a minimum range of 1,200 km and a maximum range of 5,000 km. The accuracy at maximum range is expected to be around 4,000 m CEP. The maximum range could be increased by reducing the payload.

It is reported that several new TEL vehicles have been developed by the North Koreans for the Taep'o-dong 1 missiles, probably based on tank transporter vehicles, but no details are available.

Operational status

The first flight test, using a Taep'o-dong 1 (SLV) version missile, was made in August 1998. Underground facilities have been built at Hwadae-gun test facility and at Doksong. Above ground launch sites are being constructed at Yong-dong in Chagang-Do province and at Chiha-ri, which is near Singye in Hwanghae-Pukto province, relatively near to Pyongyang. It is possible that these two above ground sites are being prepared for the commercial exploitation of the Taep'o-dong 1 (SLV) version as a satellite launch vehicle. North Korea has, in the past, built operational missiles after only one test flight, and it is believed that 10 to 20 Taep'o-dong 1 missiles may be available for operational use or further test flights. However, North Korea also builds decoy missiles and launch vehicles, so the precise number are not known.

Both Iran and Pakistan have expressed ambitions to be able to launch their own satellites and, following their previous co-operation with North Korea over the No-dong programme, it is possible that they might continue and adopt the Taep'o-dong 1 (SLV) solution as well. Iranian and Pakistani personnel were present at the August 1998 launch, and it is possible that both Shahab and Ghauri future missile or SLV versions could use the Taep'o-dong 1 technologies.



Line diagrams of the Taep'o-dong 1 and Taepb-dong 1 (SLV) missiles 0054286

Contractor

It is believed that the prime contractor is the Fourth Machine Industry Bureau, Pyongyang. The missiles are probably being built at the No 26 General Plant at Kanggye in Chagang-Do province, with final assembly and test at Hwadae-gun and Doksong.

Taep'o-dong 2

Type

Intercontinental range, liquid-propellant, single warhead, ballistic missile.

Development

Design and development of Taep'o-dong 2, possibly known as Moksong 2 or Pekdosan 2 in North Korea, probably started in 1990, at the same time that work began on Taep'o-dong 1. A mock-up was photographed by the USA at the Sanum-dong research and development facility in 1994, when the missile was described by the US as having two liquid propellant stages. The first stage was a new design, described as being similar to the Chinese Dong Feng 3 (CSS-2), and the second stage was said to be a No-dong missile assembly. Preparations were reported in June 1994 for a static test of the first-stage motor and it was noted that the missile stages were moved on separate transportation vehicles. A second first-stage motor test was reported at Sanum-dong in 1995. In 1997 a joint Taep'o-dong 1/2 underground assembly and test facility was being built at the Hwadae-gun test centre. The Taep'o-dong 2 development programme is believed to be continuing, although it is possible that success with the smaller Taep'o-dong 1 (SLV) project would delay the Taep'o-dong 2, as it seems likely that the main objective of the Taep'o-dong 2 programme might have been to develop a ballistic missile that could also be used as a satellite launch vehicle.

The links between the No-dong programme with Shahab 3 in Iran, and with Ghauri 1/2 in Pakistan, make it possible that technical assistance received by Iran and Pakistan might be fed back to North Korea and applied to the Taep'o-dong 2 programme. First stage motor tests were reported in May and July 1999, and an enlarged launch tower with increased fuel storage and pipelines were seen at the launch site in 1999, suggesting that a launch was being prepared. However, following talks with the USA, North Korea agreed to a moratorium on flight tests until 2003.

In late 1999 there were unconfirmed reports that a three-stage Taep'o-dong 3 missile or SLV was in development. A US report in March 2002 indicated that guidance assemblies and associated software were being developed for the Taep'o-dong 2 project.

Description

Taep'o-dong 2 is believed to have a length of 35.0 m and a total launch weight of 64,000 kg. The first stage is a new design, with a length of 16.0m and a body diameter of 2.1 m. This stage uses liquid propellants and probably has a total weight of around 47,000 kg. It is reported that this stage has three motors in a cluster, and uses the No-dong motor design. There is an interstage between the first-stage and second-stage assemblies with a length of 2.0 m. The second stage is based upon the No-dong missile design with a length of 17.0m, a body diameter of 1.32m and a weight of 16,000 kg. This stage uses kerosene and IRFNA liquid propellants and has a single motor. The payload assembly separates from the second stage after burn out and is believed to have a weight of 750 kg. The warhead could be nuclear, biological, chemical or HE. Guidance during the boost phases is assumed to be inertial, but it is not known if there are any mid-course or terminal guidance systems. The maximum range is believed to be around 6,000 km, although a Russian report in 1995 suggested that the range would be 9,000 km.

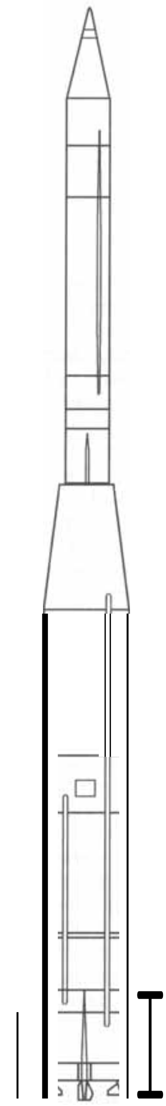
There are reported to be several new TEL vehicles developed for the Taep'o-dong 2 missile, which is probably moved in stage sections, and it is expected that these will be based on converted tank transporter vehicles.

Operational status

Little is known about this programme, except that development is believed to be continuing and a flight test could be expected whenever the moratorium is lifted. The present agreement to suspend tests expires in 2003. Initial production might start around 2004, with operational missile deployments shortly after this.

Specifications

Length: 35.0 m
Body diameter: 2.1 m/1.32 m
Launch weight: 64,000 kg
Payload: Single warhead
Warhead: 750 kg nuclear, biological, chemical or HE
Guidance: Inertial
Propulsion: Two stage liquid
Range: 6,000 km
Accuracy: n/k



Line diagram of the Taep'o-dong 2 missile
0054285

Contractors

It is believed that the prime contractor is the Fourth Machinery Industry Bureau, Pyongyang. The missiles are probably being built at the No 26 General Plant in Kanggye in Chagang-Do province, with final assembly and test at Hwadae-gun and Doksong.

PENGUIN 1/2/3 (AGM-I 19)

Type
Short-range, ship-, land- or air-launched solid-propellant, single warhead, anti-ship missiles.

Development
The Penguin 1 anti-ship missile was developed in order to meet the requirement of the Royal Norwegian Navy for an anti-invasion weapon system for small ships operating in coastal waters. Development took place during the years 1961-1970, as a joint effort by the Navy, Norwegian Defence Research Establishment (NDRE) and Norsk Forsvarsteknologi A/S (NFT) (now Kongsberg Defence and Aerospace). In 1972, the missile completed its tactical/ operational evaluation and the Penguin Mk 1 missile system became operational on the 'Storm' and 'Snogg' class Fast Attack Craft (FAC). In 1974, a new development programme was started under contract from the Royal Norwegian and Royal Swedish navies. The purpose of this programme was to increase the missile's range and incorporate some further improvements. This programme was completed in 1979, and the missile system entered production designated Penguin Mk 2.

In 1980, NFT (now Kongsberg) was awarded a contract to develop, in co-operation with the NDRE, a modified Penguin Mk 2 missile for use as an anti-ship weapon system for the Royal Norwegian Air Force (RNOAF) F-16 Fighting Falcon aircraft. The new missile, designated Penguin Mk 3, was designed to be air launched from a standard AGM-12 Bullpup pylon. Penguin Mk 3 does not have the tandem boost motor fitted to the Mk 2 ship- and helicopter-launched missiles. Initial captive carry flights were carried out using F-I04G aircraft and the first Norwegian air launch of a Penguin Mk 3 took place in 1985. In 1986, a US Air Force (USAF) F-16 launched the first of a number of Penguin Mk 3 missiles, which now had the US designation AGM-119A. These USAF tests were part of the system integration evaluation under a Belgium, Denmark, Netherlands, Norway and USA sponsored F-16A/B Operational Capability Upgrade (OCU) programme.

Penguin Mk 3 entered service with the RNOAF in 1989 for use on the centre wing pylon of the F-16 Fighting Falcon.

Although helicopter launching of the Penguin Mk 2 was considered by a Norwegian feasibility study as early as 1981, US Navy interest became the driving force behind the new missile version, designated Mk 2 Mod 7 and later AGM-119B. The United States Navy (USN) began to assess its requirement for a helicopter-launched anti-ship missile in 1983 and, in 1984, it concluded that Penguin could be adapted for use on the SH-GOB Sea Hawk for the USN LAMPS III programme. Tests carried out in 1986 showed that the missile could be carried for air-to-surface roles, without reducing the SH-60B's effectiveness in its prime ASW role. The Penguin Mk 2 Mod 7 retains the Mk 2 tandem booster motor, incorporates several of the improvements introduced in the Mk 3 variant and the folding-wings allow up to four weapons to be carried (two on either side of the helicopter).

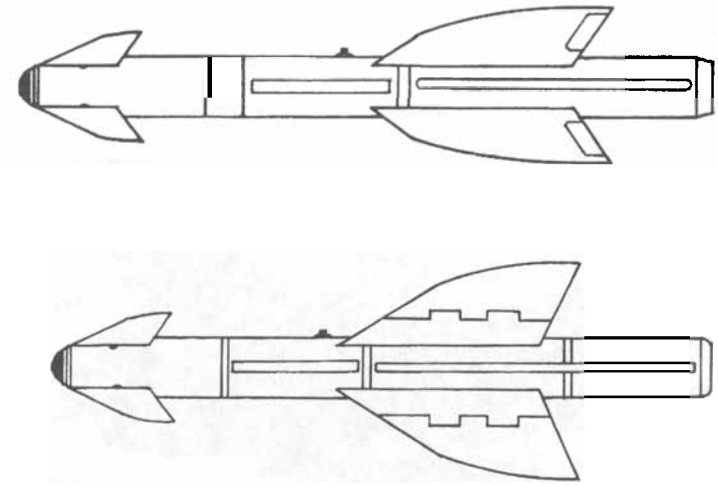
In 1986, an agreement was signed between Grumman (now Northrop Grumman) and NFT (now Kongsberg Defence and Aerospace) to develop jointly the Mk 2 Mod 7 missile and SH-GOB Seahawk modifications. In 1989, a USN advanced acquisition contract was placed for a first series production batch of Penguin Mk 2 Mod 7 missiles and associated equipment. In 1991, it was reported that the system integration programme had been concluded and that both technical evaluation and operational evaluation had been successfully completed. As well as being cleared for use from the SH-GOB Seahawk, the Penguin Mk 2 Mod 7 has also been cleared for carriage on the Westland Super Lynx, SH-2G Seasprite and S-70B helicopters. Flight tests started in 2000 to clear the missile for use on Australian SH-2G(A) Super Seasprite helicopters, to be used from Anzac (MEKO 200) class frigates. In 2000, ADI in Australia completed the development and started to manufacture a new insensitive munition warhead for the Penguin Mk 2 missiles, to improve safety during their storage on ships. The Mk 2 Mod 7 missile has also been adapted for tube-launching from ships and coastal defence batteries.

Penguin Mk 2 missiles have been fitted to 'Oslo' class frigates and to 'Storm', 'Hawk', 'La Combattante III', 'Kartal', 'Snogg', 'Hugin' and 'Norrkoping' class fast attack craft.

Reports since 1990 have indicated that design studies have been made for a Penguin Mk 4 missile with increased range and, in 1994, this was renamed the Nytt Sjomals Missil (NSM). Further details of the NSM programme can be found in the Unclassified Projects section, under International programmes. In 1998, Kongsberg proposed a new IIR seeker for Penguin missiles, believed to be based on the seeker selected for the NSM programme.

F-16 Fighting Falcon of the Royal Norwegian Air Force fitted with AGM-119A Penguin Mk 3 anti-ship missiles (NFT)

AGM-119B Penguin Mk 2 Mod 7 on display at 1991 Paris Air Show (Peter Humphris)



Line diagrarns of Penguin Mk 3 IAGM-119A) (above) and Penguin Mk 2 Mod 7 (AGM-119B) (below)

Description

The Penguin Mk 2, ship-launched, anti-ship missile system consists of the missile in its box launcher/transport container, missile control cabinet, operational panel, bridge firing panel and safety-arming unit. The missile is a short-range, inertial and IR-guided weapon powered by a solid-propellant motor system and armed with an HE Semi-Armour-Piercing (SAP)warhead. It has a cylindrical body with a tapered nose section that has a rounded glass dome nose and four swept canard control fins. Just aft of mid-body are four in-line, rounded, leading-edge delta wings with ailerons for roll stabilisation. The Penguin missile is made up of three major assemblies. A nose section that contains the target seeker, digital autopilot, control system, altimeter and inertial navigation unit. A centre section that contains the 120 kg Bullpup Mk 19 SAP warhead with a charge of 50 kg High Explosive (HE), delayed impact fuze and safety and arming devices. A rear section that contains the solid-propellant sustainer motor. Before launch, the missile is fitted with a tandem booster motor, which is jettisoned in flight when the missile has reached cruising speed. At launch, the Penguin Mk 2 missile is 2.96 m long, has a body diameter of 0.28 m, a wing span of 1.4 m and weighs 385 kg. Guidance in the mid-course phase is by inertial navigation which guides the missile towards the computed target intercept point, either along a straight course, or following a right or left turn dog-leg trajectory. The navigation system also corrects for ship movement at the instant of launch, aim-offs up to plus or minus 50" and any cross-wind components that may be encountered during the mid-course flight. Level flight at an altitude of 80 m is maintained by inertial platform, being updated by a pulsed laser altimeter. The terminal phase is controlled by a mechanically scanning passive infra-red seeker. This has the capability of autonomously searching the area ahead of the missile, acquiring and classifying the target and changing from the search to the track mode.

The original Norwegian fire-control unit for the Penguin shipborne system was the MSI-80S. This combined twin Decca TM1226 radars, a GEC-Marconi low-light TV camera tracker, laser range-finder, IR scanner and Electronic Warfare (EW) sensors. A modified version of the MSI-80S was developed for US application known as the Penguin Missile Control System (MCS). This unit is believed to differ from the original in the replacement of some components, such as the radar, speed log and compass with equivalent American units and the substitution of a mini-FLIR (Forward-Looking Infra-Red) thermal imager for the TV camera. For Royal Swedish Navy service, Penguin is interfaced with a PEAB 9V200 Mk 2 fire-control system and the Greek Navy operates the system in conjunction with a Thompson-CSF (now Thales) Vega 2 Fire-Control System.

The missile, in its sealed container, is placed on a special ramped deck mounting and connected by an umbilical cord to the missile control cabinet, operation panel, bridge firing panel and safety-arming unit. The Penguin weapon system will normally be operated from the operator's panel, which may be integrated in the ship's fire-control system. At the operation panel the operator can select, start and check the missile, select single or salvo firing, straight or dog-leg trajectories and so on. Once launched, the missile is carried clear of the ship by the booster motor, accelerated to its cruise speed of M0.9 and flies towards the target area at an altitude of 80 m. When the missile approaches the target area, the seeker is activated and commences to search a strip of the sea surface ahead of the missile. When the seeker has detected an object that satisfies the decision criteria, it automatically changes to its track-while-scan mode for the terminal guidance. The seeker will then guide the missile to an impact point close to the target waterline. The all-digital signal processing simplifies discrimination between decoys and real targets, giving the seeker a high resistance against IR countermeasures both in search and track mode. The weapon operator can also select and attack a specific ship within a formation. The Penguin Mk 2 Surface-to-Surface Missile (SSM) is credited with a maximum effective range of 30 km.

The Penguin Mk 3 (AGM-119A) air-launched variant is basically a modified Mk 2. It has slightly smaller fixed wings, a larger sustainer motor and because it is launched from fixed-wing aircraft does not require a booster motor. The Mk 3 is 3.2 m long, has a body diameter of 0.28 m, a wingspan of 1.0 m and weighs 370 kg. This version has a larger 130 kg high explosive and semi-armour-piercing warhead. Once launched, the missile descends to its cruise altitude and operates in the same manner as the ship-launched version. The Penguin Mk 3 has an operational range of 55 km.

The Penguin Mk 2 Mod 7 (AGM-119B) is an updated Mk 2 for use from helicopters and, as such, requires a booster motor. The other major difference is the use of folding wings in order to provide the necessary clearance for helicopter carriage. The Mk 2 Mod 7 is 3.0 m long, has a body diameter of 0.28 m and weighs 385 kg. It has a folded wingspan of 0.56 m and an in-flight span of 1.4 m. Once launched, the missile operates in the same manner as the other variants and is credited with a maximum range of 35 km. The Penguin Mk 2 Mod 7 has also been adapted for use from ships and coastal batteries and, because of its folded-wing arrangement, smaller diameter launch tubes and multiple canister launchers can be used.

The Royal Norwegian Navy fast patrol boat 'Traust' with six Penguin Mk 2 launch units

Operational status

Penguin Mk 1 missiles entered service on Royal Norwegian Navy and Turkish Navy fast attack craft in 1972. The improved ship- or coastal-launched Mk 2 version entered service in 1979. In 1990, it was reported that the ship-launched Penguin system was in operation with four navies on approximately 80 vessels. These include; Greece, Norway, Sweden and Turkey. Except for the Mk 1s used in the Turkish Navy and a few found on older Norwegian vessels, most of the original Mk 1 missiles have been brought up to Mk 2 standard. However, a test programme in 1994 indicated that some older missiles were unreliable and it is believed that the Mk 1s have been removed from service. An agreement in 1997 provided for a service life extension of the Penguin Mk 2 Mod 5 standard missiles in service with the Royal Norwegian Navy until 2015. Development of the Penguin Mk 3 (AGM-119A) began in 1979 and entered service with the RNOAF in 1989. The USAF test fired seven AGM-119A missiles in 1988 from F-16 aircraft. It is believed that 150 Penguin Mk 3 missiles were built.

The Penguin Mk 2 Mod 7 (AGM-119B) helicopter version was to have been used by the USN's LAMPS III programme, but reports in 1994 indicated that the USN had only bought 101 of the planned 193 Penguin missiles and had cancelled its last two options under the 1990 contract. It is believed that a second order for 90 missiles was placed in 1996. Several AGM-119 B missiles were fired from US Navy SH-60B Seahawk helicopters against a ship target in August 1998. Greece ordered Penguin Mk 2 Mod 7 missiles for use from its S-70B helicopters in 1993 and added a second order in 1996. Australia selected Penguin Mk 2 Mod 7 missiles to arm its SH-2G(A) Super Seasprite helicopters in 1997, with an initial order for 44 missiles. These missiles started delivery in October 2001. Unconfirmed reports suggest that Singapore and Turkey have evaluated Penguin Mk 2 Mod 7 and Mk 3 missiles for further export orders. and that an order for Turkey to purchase 40 missiles to arm their S-70B Seahawk helicopters was reconfirmed in 1998. However, in November 1999 it was reported that the Turkish order had been cancelled again. It is believed that Spain will order some Mk 2 Mod 7 missiles in 2000, for use by its SH-70L Seahawk helicopters on four F-100 frigates, which are due to enter service in 2003. Spain is also expected to order some Mk 3 missiles for use from its AV-8B Harrier II aircraft. In July 2000, Greece tested four Mk 2 Mod 3 missiles launched from a Laskos (Combattante III) FAC against ship targets, and one Mk 2 Mod 7 launched from a S-70B helicopter.

Specifications

	Penguin Mk 2 SSM version	Penguin Mk 2 helicopter Mod 7 ASM version	Penguin Mk 3 aircraft ASM version
Length	2.96 m	3.0 m	3.2 m
Body diameter	0.28 m	0.28 m	0.28 m
Launch weight	385 kg	385 kg	370 kg
Payload	Single warhead	Single warhead	Single warhead
Warhead	120 kg HE/SAP	120 kg HE/SAP	130 kg HE/SAP
Guidance	Inertial and passive IR	Inertial and passive IR	Inertial and passive IR
Propulsion	Solid propellant	Solid propellant	Solid propellant
Range	30 km	35 km	55 km
Accuracy	n/k	n/k	n/k

Contractor

Kongsberg Defence and Aerospace, Kongsberg (prime contractor).

Hatf I

Type

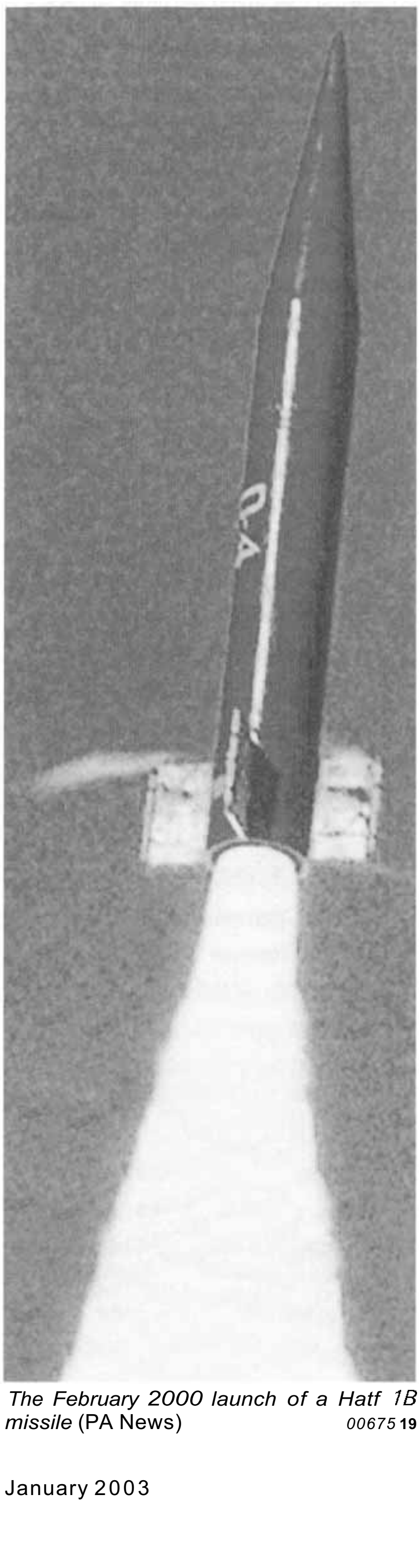
Short-range, road mobile, solid-propellant, single warhead unguided rocket and ballistic missile.

Development

It is believed that development of the Hatf (Deadly) solid-propellant unguided rocket and ballistic missile programme started in the early 1980s and, although the Pakistan government claims they were indigenously built, there were persistent reports that the Chinese and some European companies provided assistance. There are unconfirmed reports that the initial Hatf 1 and 2 project designs were both based upon a 1960s French-sounding rocket design, known as Eridan. There were conflicting reports of a missile programme known as Shadoz (King Hawk), but this may have referred to the early Hatf 2 programme. An early report suggested that the Hatf 1 missiles were SS-1 'Scud' variants, but this has been shown to be incorrect.

However, it has now become clear that there were two distinct and separate ballistic missile development teams in Pakistan, and that the Hatf name refers to both the liquid-propellant and solid-propellant projects. Solid propellant Hatf 1 and 2 missiles were both revealed by the Pakistan authorities in early 1989. The Hatf 2 design was for a two-stage missile, using the Hatf 1 missile as the second stage. It is believed that the original Hatf 1 was an unguided rocket, designed by the Pakistan National Development Complex (PNDC) with close co-operation from the Pakistan Space and Upper Atmosphere Research Commission (SUPARCO). SUPARCO had been building and launching solid propellant multistage space research launch vehicles since the early 1960s. and in 1989 launched a rocket with a 150 kg payload to an altitude of 480 km. There have been many reports, denied by Pakistan and China, that China exported 34 M-11 missiles to Pakistan in 1993, and it is believed that the original Hatf 2 programme was terminated in 1994.

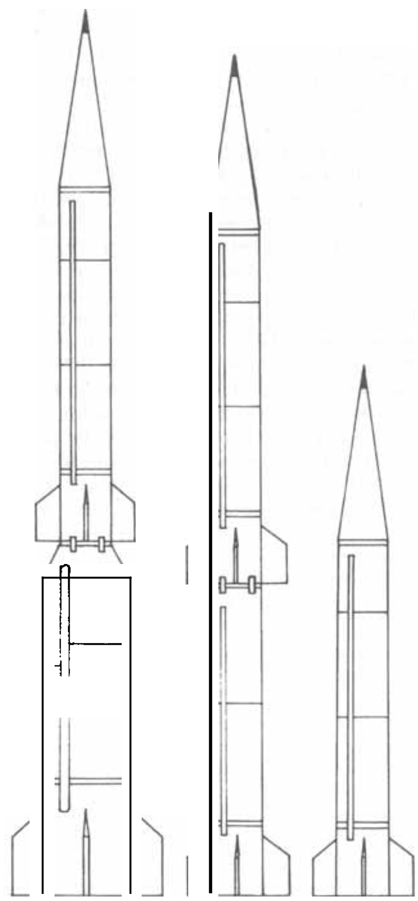
Reports in 1992 indicated that an improved Hatf 1, known as Hatf 1A, had been developed with a range of 100 km, and it was assumed that this was also an unguided missile. In February 2000, an improved Hatf 1 missile was tested, and official Pakistan statements indicated that this missile was guided and had a new warhead. It is believed that this test was of a Hatf 1B missile.



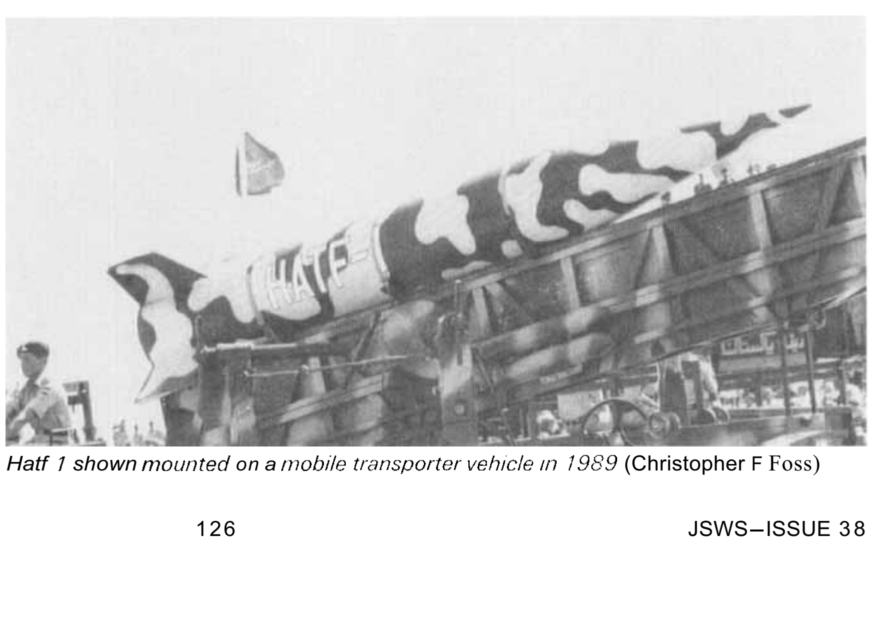
The February 2000 launch of a Hatf 1B missile (PA News) *0067519*

Description

Hatf 1 is believed to be an 80 km range unguided rocket, with a length of 6.0 m, a body diameter of 0.56 m and a launch weight believed to be around 1,500 kg. The rocket is a single-stage solid-propellant system, with a payload of 500 kg that could be HE, chemical or submunitions. Trials of an improved version, known as Hatf 1A, with a range increased to 100 km and improved accuracy started in 1991. It is likely that both Hatf 1 and Hatf 1A are unguided rockets, similar to the Iranian Nazeat family. This view is supported by the long launch ramp always seen with the



A line diagram of the original Hatf family of missiles: showing from right to left the Hatf 1, Hatf 2 and Hatf 3 missiles



Hatf 1 shown mounted on a mobile transporter vehicle in 1989 (Christopher F Foss)

Hatf 1. A guided version, believed to be designated Hatf 1B, was first tested in 2000 and was reported to have a new warhead and a range of 100 km. It is assumed that the guidance is inertial, and that control is achieved through moving rear control fins or by vanes in the motor exhaust efflux. It would seem unlikely that a missile with such a short range would be given a nuclear warhead, and it is possible that the guided version has a new warhead with improved chemical or HE submunitions.

Both Hatf 1 and the original Hatf 2 missiles were ground mobile; the Hatf 1 missiles have been seen carried on a four wheeled Transporter-Erector-Launcher (TEL) with a 12 m ramp. The Hatf 2 missiles displayed in Rawalpindi in March 1989 were mounted on ex-Second World War anti-aircraft gun converted trailers, rather than on a modern missile TEL vehicle. It is believed that a more modern TEL has now been developed for the Hatf 1B missile.

Operational status

The development programmes for the original Hatf 1 and 2 probably started in the early 1980s, and the first test firings were reported in February 1989. Although the 500 kg payload of both Hatf missiles might be adequate for nuclear warheads with yields in the 1 to 5 kT region, it is assumed that conventional High Explosive (HE), submunition or chemical warheads have been developed for these short-range missiles. It is believed that Hatf 1 entered service in 1992 and an improved Hatf 1A, with an increased range, is believed to have entered service in 1995. The guided Hatf 1B version was flight tested in February 2000 and has probably started to be operational with upgrade kits fitted to existing missiles.

Specifications

Hatf **1**
Length: 6.0 m
Body diameter: 0.56 m
Launch weight: 1,500 kg
Payload: Single warhead; 500 kg
Warhead: HE, submunitions or chemical
Guidance: Unguided (1 and 1A), Inertial (1B)
Propulsion: Solid propellant
Range: 80 km (Hatf 1), 100 km (Hatf 1A/1B)
Accuracy: n/k

Contractor

The Hatf 1 missiles have been designed and developed by the Pakistan National Development Complex, Islamabad.

Hatf 2 (Abdali)

Type
Short-range, road mobile, solid propellant, single warhead ballistic missile.

Development
The original design for a Hatf 2 SRBM was started in 1987, and first displayed in 1989 as a two-stage version of the Hatf 1 missile. This version used the Hatf 1 missile as the second stage, with a larger boost motor for the first stage, and had a range of 300 km with a 500 kg payload. The programme was delayed, probably due to the purchase of Chinese M-11 missiles in 1992, and was terminated in 1994. A new design was started by the Pakistan National Development Complex in 1997, with the range reduced to 180 km, and this was called Hatf 2 or Abdali. This missile is a single-stage SRBM, and probably uses technologies and components already developed for the Hatf 1B and Hatf 3 missiles. The requirement would probably have been to develop a lower cost short-range missile, to supplement the limited numbers of M-11 purchased. The Abdali missile was first flight tested in May 2002, and appears similar in size and shape to the Argentinian Alacran SRBM and the Chinese TY-3 research rocket. The TY-3 research rocket has a length of 6.2 m, body diameter of 0.45 m, and a weight of 1,100 kg. This rocket can carry a 160 kg payload to 220 km altitude, and was designed by the Fourth Academy of CASC. Later versions of the Abdali missile may have GPS or terminal guidance for increased accuracy.

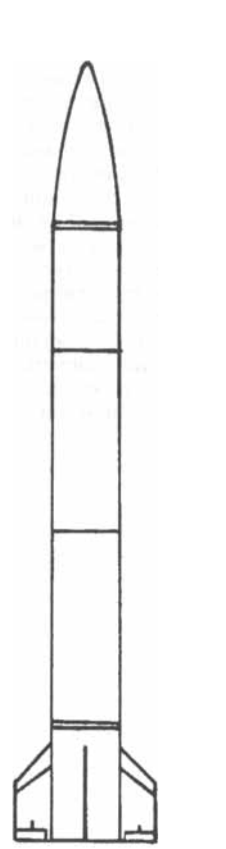

The new design Abdali (Hatf 2) missile at launch in May 2002 (PA News) *NEW*/0145012

Description
The Abdali (Hatf 2) missile is believed to have a length of 6.5 m, a body diameter of 0.56 m, and a launch weight of 1,250 to 1,500 kg. The missile has an ogival nose, and four clipped-tip delta fins at the rear. The payload can probably be varied between 250 and 450 kg, carrying HE unitary or submunition warheads. The warhead assembly probably does not separate from the missile. Guidance is believed to be inertial, giving an accuracy of around 150 m CEP. Future versions may have GPS or terminal guidance, which could improve the accuracy to 30 m CEP. The minimum range is estimated to be 40 km, and the maximum range is 180 km.

The missile is carried on a road-mobile TEL vehicle, which is probably similar to the Russian MAZ 543 used for the Ghaznavi (Hatf 3) or the modified truck used for Hatf 1. The Hatf 1 truck launch vehicle has a bulky beam type launch arm, which would have been developed for an unguided rocket launch, and is similar to the launcher used for the Chinese TY-3 rocket system.

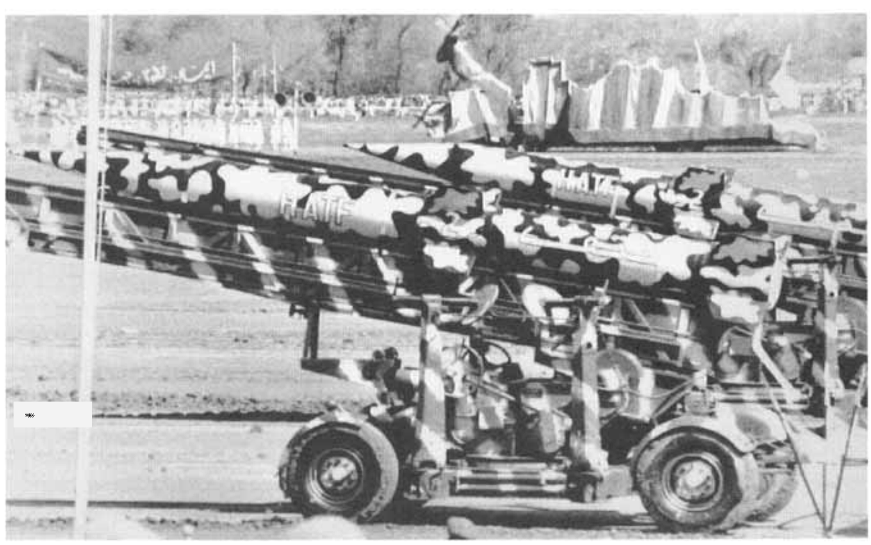
Operational status
The original two-stage Hatf 2 missile design was displayed in 1989. The Abdali SRBM was first tested in May 2002, and it is expected that the first missiles may enter service in 2003.

Specifications
Length: 6.5 m
Body diameter: 0.56 m
Launch weight: 1,250 – 1,500 kg
Payload: Single warhead, 250 – 450 kg
Warhead: HE or submunitions
Guidance: Inertial


Line diagram of Abdali missile *NEW*/0145013

Propulsion: Single-stage solid propellant
Range: 180 km
Accuracy: 150 m CEP

Contractor
The prime contractor is believed to be the Pakistan National Development Complex at Islamabad.



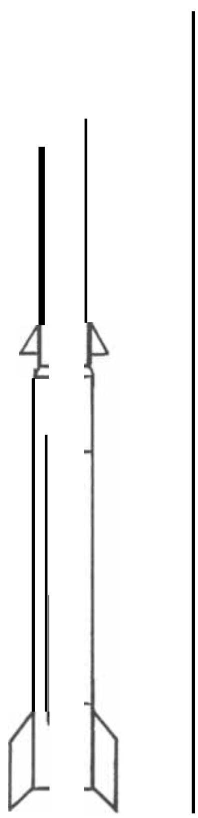
The original design missile for Hatf 2, displayed in Rawalpindi in 1989 *NEW*/0145011

Hatf 3 (Ghaznavi)

Type
Short-range, road mobile, solid propellant, single warhead ballistic missile.

Development
The original Hatf 3 missile development programme started in 1987. This version was a two-stage missile, using the design for the original Hatf 2 with a larger boost motor assembly to give a maximum range of 800 km. This programme was terminated in 1994, following the purchase of M-11 missiles from China. The M-11 missiles were stored at Sagodha air base, and it is believed that the technologies were adapted to design the Shaheen 1 (Hatf 4) and Shaheen 2 (Hatf 6) missiles. As a lower priority Pakistan has now developed a new version of Hatf 3, called Ghaznavi, and development for this version started in 1997. The first flight test was made in May 2002. From this test launch it appears that Ghaznavi is either a re-painted M-11, a version of the M-11 built in Pakistan from components and assemblies supplied by China, or a locally built variant of the M-11. The Ghaznavi will benefit from the technologies already developed for the Shaheen 1/2 missiles, and has been developed by the Pakistan National Development Complex. Future versions may have GPS or terminal guidance systems added for improved accuracy.

Description
The Ghaznavi (Hatf 3) missile is 8.5 m long, has a body diameter of 0.8 m, and a launch weight of 4,000 kg. The payload assembly separates from the motor after burn-out, or before re-entry The payload is believed to be 500 kg, and the warhead could be nuclear 12 to 20 kT, HE unitary or submunitions. Guidance is inertial, but the payload assembly could have some form of terminal guidance, probably an optical terrain correlation system. The payload assembly has four small control fins at the



Line diagram **of** *Ghaznavimissi*

NEW/0145009

A Ghaznavi (Hatf 3) missile on its TEL, raised ready for launch in May 2002 (PA News)

NEW/0145014

rear, which could be used to correct the trajectory following re-entry. The motor is a single-stage solid propellant system, providing a minimum range of around 50 km and a maximum range of 290 km. However, the Chinese M-11 Mod 1 (CSS-7) missile is now reported to have a maximum range of 350 km, which exceeds the MTCR limit of 300 km, and it is possible that Ghaznavi also has a maximum range of around 350 km. The accuracy is believed to be 250 m CEP at full range, although if a terminal guidance system is used then the accuracy would probably be around 50 m CEP.

The TEL is a modified version of the Russian MAZ 543, first used with the former USSR for the SS-1 'Scud B'. The modified TEL is used in Pakistan with the Shaheen 1 (Hatf 4) missile system. This wheeled TEL has a length of 16.5 m, a width of 3.02 m, and an empty weight of 38,000 kg. The vehicle has a crew of three, a road speed of 55 km/hr, and an unrefueled range of 650 km. Four stabilising jacks are lowered before launch, and a hydraulically powered launching arm is raised to the vertical with the missile attached for launch.

Operational status

Development for Ghaznavi started in 1997, and the first flight test was carried out in May 2002. M-11 missiles were reported to have entered service in Pakistan with 155 Regiment at Attock in 1997, and it is expected that the Ghaznavi missiles will become operational in 2003.

Specifications

Length: 8.5 m
Body diameter: 0.8 m
Launch weight: 4,000 kg
Payload: Single warhead, 500 kg
Warhead: Nuclear 12 to 20 kT, HE or submunitions
Guidance: Inertial
Propulsion: Single-stage solid propellant
Range: 290 km
Accuracy: 250 m CEP

Contractor

The prime contractor is believed to be the Pakistan National Development Complex at Islamabad.

Hatf 4 (Shaheen I)

Type

Intermediate range, solid-propellant, single warhead, ballistic missile.

Development

There were reports that Pakistan had received 34 Chinese M-11 (DF-11, CSS-7) missiles around 1993, and that a production facility for further missiles was being built in Pakistan. The Chinese M-11 missile was originally designed for export, with development starting in 1984, and the first flight test was made in 1990. The missile was then adopted by the PLA, given the Chinese designator DF-11, and is believed to have entered service in China in 1992. Since 1996 there have been suggestions that a solid-propellant missile was being developed by Pakistan, with the name Shaheen 1, Tarmuk or Hatf 4. Ground tests of the motor for this missile were reported in 1997 and 1998. There was a possible flight test in July 1997, although other reports ascribed this flight to Hatf 3. The Shaheen 1 missile, also known as Hatf 4, was developed between 1993 and 1997, and was first displayed in March 1999 mounted on its TEL vehicle, and looks similar to a scaled-up variant of the Chinese M-11 missile. It is believed that the Shaheen 1 was developed by the Pakistan National Development Complex (PNDC), possibly with assistance from SUPARCO, the Pakistan space research organisation and the Atomic Energy Commission. SUPARCO has had considerable experience with solid-propellant sounding rockets since the 1960s. It is also possible that Chinese engineers assisted with the Shaheen 1 programme.

Shaheen 1 was first tested in April 1999, with a launch from the Ormara naval base in Southern Pakistan to the Chagi Desert, a flight of 450 km that lasted for 6 minutes and 12 seconds.

A Shaheen 2 (probably Hatf 6) missile is also in development, and was first displayed in March 2000. This is a two-stage solid-propellant missile with a maximum range of 2,500 km. It is believed that the first stage is a version of the motor assembly from Shaheen 1, and that the second stage is similar to a complete Shaheen 1 including the same payload.

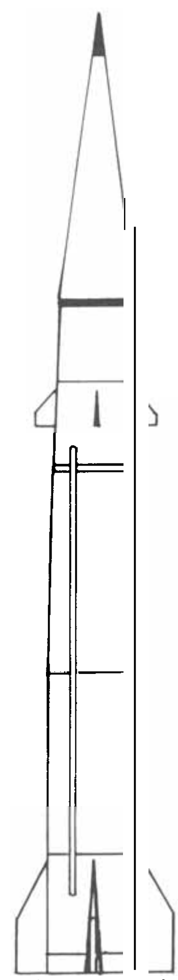
Description

There had been little technical information released about the Shaheen 1 missile, apart from the maximum range which was initially reported to be 750 km but then reduced to 600 km, prior to the first flight test. From the model displayed in March 1999 some conclusions can be drawn, as the missile was carried on a modified MAZ 543 TEL similar to that used with the Russian SS-1 'Scud B' missile system. This modified TEL is believed to have a length of 16.5 m, with a strengthened rear missile launch platform assembly. The Shaheen 1 missile has a length of 12.0 m, a body diameter of 1.0 m, and a launch weight of 9,500 kg. The missile has inertial guidance during the boost phase, but there is not expected to be mid-course guidance. Shaheen 1 is a single-stage solid-propellant missile, with approximately 7,000 kg of HTPB propellant and a motor assembly weighing 1,000 kg. There are four large fixed wings at the rear of the missile and four small delta control fins at the rear of the payload bay. It is assumed that the payload separates from the boost motor assembly after burn out, but an unconfirmed report suggested that the payload separates after re-entry into the atmosphere, at an altitude of 40 km. The payload bay has four small SM-03 solid-propellant motors at the rear, each weighing 1.8 kg, which are used after boost burn out or prior to re-entry to align the warhead for improved accuracy. The small fins on the payload bay would

A Shaheen I (Hatf 4) missile on its TEL vehicle. displayed in March 1999 (PA News)

0054284

A Shaheen 1 TEL vehicle displayed in November 2000 (Andrew Koch) ***NEW***/0114345



*Line diagram **of** a Shaheen 1 missile*

0054283

possibly provide stabilisation near the target, although it is possible that an INS/GPS terminal guidance system has been included and the small fins provide control in the lower atmosphere after re-entry. The payload bay weight is reported to be 1,000 kg, and this could carry a 750 kg warhead, possibly 35 kT nuclear, chemical, unitary HE or submunitions. An accuracy of 200 m CEP has been reported. The minimum range is believed to be 150 km and the maximum range 600 km.

The TEL vehicle displayed looked like a modified MAZ 543 vehicle, but with the rear half of the vehicle adapted to carry a larger and heavier missile. It is believed that the modified TEL has a length of 16.5 m, a width of 3.02 m, an empty weight of 38,000 kg and a loaded weight of 47,000 kg. The MAZ 543 has a road speed of 55 km/h and an unrefuelled range of 650 km. The diesel engine develops 525 hp and there is a separate 10 kW electric generator for the operation of the missile. The missile is raised to the vertical for launch from the rear platform and the vehicle is stabilised by four hydraulic jacks prior to missile launch. With a solid-propellant missile the launch preparations are short, and it could be expected that a missile could be launched within 5 to 10 minutes of arrival at a pre-surveyed site. It is believed that the Hatf 3 (Ghaznavi) missile uses a similar TEL.

Operational status

There are believed to have been two static motor tests in 1997 and 1998 for the Shaheen 1 missile, but there was also an unconfirmed report of a possible test flight in July 1997, although recent reports from Pakistan state that the April 1999 flight test was the first. The test in April 1999 is reported to have flown 450 km. It is also reported that initial low-rate production started in mid-1998, and that possibly five to ten missiles were available for testing or operational use by the end of 1999. As the Shaheen 2 missile is believed to use the Shaheen 1 missile as its second stage, the production and operational numbers of Shaheen 1 have to be considered with care. It is expected that the final assembly and test of the Shaheen 1 missile is co-located with that for the Hatf 3 (Ghaznavi), which is believed to be at Fatch Jung.

Specifications

Shaheen 1
Length: 12.0 m
Body diameter: 1.0 m
Launch weight: 9,500 kg
Payload: Single warhead 1,000 kg
Warhead: 750 kg nuclear 35 kT, chemical, HE or submunitions
Guidance: Inertial
Propulsion: Single-stage solid propellant
Range: 600 km
Accuracy: 200 m CEP

Contractor

The prime contractor is believed to be the Pakistan National Development Complex, Islamabad, with assistance from SUPARCO and the Atomic Energy Commission.

Hatf 5 (Ghauri 1/2)

Type

Intermediate-range, road mobile, liquid-propellant, single warhead ballistic missiles

Development

It is believed that the Hatf 5, Ghauri 1 or Mark III ballistic missile development programme started in Pakistan at the Khan Research Laboratories in 1993, but it was only publicly announced in 1997. An engine test was carried out in January 1998, and the first flight test was made in April 1998. Although Pakistan officials state that the Ghauri 1 is an indigenous design and development, it is generally viewed as having been based upon North Korean No-dong 1/2 technology. It is reported, though denied by North Korea, that 5 to 12 No-dong missile assembly sets were sent to Pakistan between 1994 and 1997, for trials and to set-up a manufacturing capability. There have also been unconfirmed reports that Chinese guidance systems have been used, although these may have been passed through North Korea.

Iran has developed the Shahab 3 missile, which appears to be similar to the Ghauri 1, and there are reports that Iran and Pakistan have co-operated together with North Korea and that the three programmes are closely related.

A second ballistic missile, called Hatf 5A or Ghauri 2, was announced in 1998, with a range of 1,800 to 2,300 km, which uses a longer Ghauri 1 motor assembly. This missile might be similar to the Iranian Shahab 4 project. A Ghauri 2 missile was first flight tested in April 1999.

A further Pakistani missile development programme was named as Babri, and it is assumed that this might refer to a follow-on system with greater range. A Ghauri 3 programme was reported to have been in development since 1994, with a range of 3,000 km, and first stage motor tests were made in July and September 1999. It is possible that one of these might form the basis for a satellite launch vehicle, probably based upon the North Korean Taep'o-dong 1 (SLV) design and using the Hatf 5A (Ghauri 2) missile as the first stage.

Description

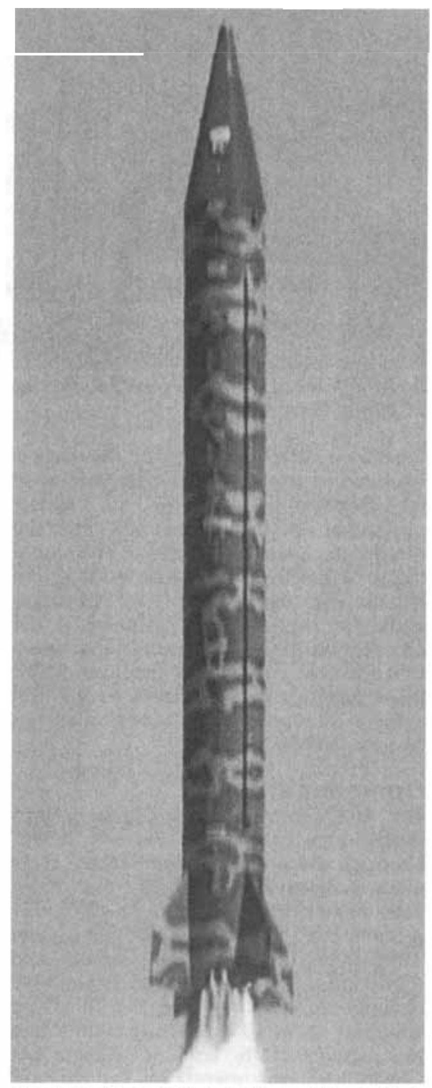
The Ghauri 1 missile has a length of 15.9 m, a body diameter of 1.35 m and a launch weight of 15,850 kg. The missile shape is similar to that of the Russian 'Scud B' and appears to have been scaled up, using a similar length to diameter ratio. A payload of 1,200 kg and a separating warhead assembly could carry nuclear, chemical, HE or submunitions warheads. The warhead is believed to weigh 760 kg, and it is believed that the initial design was for a 15 to 35 kT nuclear warhead, similar to that tested by Pakistan in May 1998. The missile has a single-stage liquid-propellant system, probably using kerosene and IRFNA with a total propellant weight of 12,200 kg, and a burn time of around 100 seconds. There is a single motor assembly, fed by a turbopump powered by compressed air. Guidance is believed to be inertial and although reports from Pakistan suggest that Chinese assistance was given with the guidance, an accuracy of 2,500 m CEP is believed to have been achieved. Control of the missile during the boost phase is by vanes in the motor exhaust, driven by compressed air. The minimum range is expected to be 400 km, and the maximum range 1,500 km.

Pakistan has several different types of mobile TEL in use with its ballistic missiles, and has adapted the Russian MAZ 543 'Scud B' TEL vehicle with the addition of one or two more axles for use with the Ghauri 1 missile. There have been some converted commercial articulated vehicles (6 × 4) used to carry the missiles for displays and also for the first launch in April 1998. A modified tank transporter vehicle was displayed as a TEL in March 2000, and it is believed that this vehicle can carry either Ghauri 1 or Ghauri 2 missiles.

The Ghauri 2 missile is almost identical in shape to the Ghauri 1, and few details have been released. The missile is believed to be simply an improved and lengthened version of Ghauri 1, possibly using improved propellants with a new motor assembly. The length is believed to be 18.0 m, the body diameter 1.35 m and the launch weight 17,800 kg. The payload has

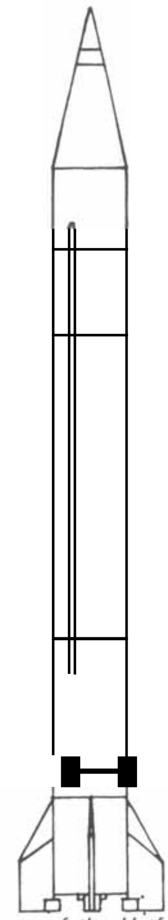
A converted tank transporter TEL carrying a Ghauri 1 missile during a display in March 2000 (PA News) 0089135

A Hatf 5A (Ghauri 2) ballistic missile displayed in March 1999 (PA News) 0054282



The launch of a Hatf 5A (Ghauri 2) missile in April 1999 (PA News) 0054281

A Hatf 5 (Ghauri 1) missile raised to the launch position on its TEL. displayed in November 2000 (Andrew Koch) NEW/0114347



A line diagram of the Hatf 5 (Ghauri 1) ballistic missile 0022170

been reduced to 1,000 kg and the nuclear warhead design may have been improved with a weight reduced to 750 kg. A lighter payload of 750 kg may be used when the maximum range is required. A maximum range of 1,800 km was reported after the launch, with the addition that this range could be increased to 2,300 km if the payload weight was reduced. It is possible that the real objective of the April 1999 flight was to test this missile as the first stage in a future satellite launch vehicle or two-stage IRBM.

Operational status

The first engine test on Ghauri 1 was reported in Pakistan in January 1998, although there were several motor tests made in North Korea in 1997 that might have been connected with the Ghauri 1 programme. The first flight test was in April 1998, over a distance of between 800 and 1,200 km, although the most probable distance seems to be 1.150 km. This flight lasted for about 10 minutes and was lofted to an apogee of 350 km. It is believed that Ghauri 1 entered operational service later in 1998, and that by mid-1999 there were some 5 to 10 missiles available for further tests or operational use. A second flight test was made in May 2002, and this is reported to have flown 1,500 km. The operational missiles will be used by the Pakistan Army's 47th Artillery Brigade.

Ghauri 2 is reported to be in development and the first flight test was made in April 1999. This flight travelled 1,165 km in around 12 minutes. It is not clear if this missile will be built for operational use, or for use as the first stage of a two-stage missile or SLV.

Both the Ghauri 1 and 2 programmes appear to have been developed with considerable assistance from North Korea, and to be based upon the No-dong 1/2 design and technologies. It appears that there has also been co-operation between Pakistan and Iran, as the Ghauri 1 and Shahab 3 missiles appear to be similar as well. The balance of evidence suggests that there has in fact been a co-ordinated programme between the three countries from around 1993.

A Ghauri 3 missile has been reported to have been in development since 1994, with a range of 3,000 km, and two first-stage motor tests were made in July and September 1999.

An unconfirmed report in 2000 suggested that the liquid-propellant Ghauri missile programmes would be terminated, and diverted into a possible satellite launch vehicle project. The solid-propellant Shaheen missile programmes would be continued for operational use, as they were easier to prepare, required fewer support vehicles and personnel, and were more accurate.

Specifications

Hatf 5 (Ghauri 1)
Length: 15.9 m
Body diameter: 1.35 m
Launch weight: 15,850 kg
Payload: Single warhead 1,200 kg
Warhead: 760 kg nuclear 15 to 35 kT, chemical, HE or submunitions
Guidance: Inertial
Propulsion: Single-stage liquid propellant
Range: 1,500 km
Accuracy: 2,500 m CEP

Hatf 5A (Ghauri 2)
Length: 18.0 m
Body diameter: 1.35 m
Launch weight: 17,800 kg
Payload: Single warhead, 750 or 1,000 kg
Warhead: 750 kg nuclear 15 to 35 kt
Guidance: Inertial
Propulsion: Single-stage liquid propellant
Range: 1,800 to 2,300 km
Accuracy: n/k

Contractor

Khan Research Laboratories, Kahuta.

Hatf 6 (Shaheen 2)

Type

Intermediate range, solid-propellant, single warhead, ballistic missile.

Development

There were unconfirmed reports that a Shaheen 2 (believed to have the designator Hatf 6) two-stage solid-propellant ballistic missile had been developed, and that it was ready for flight testing in June 1999. However, the missile was first displayed in March 2000, and the first test flight is expected in the near future.

Shaheen 2 appears to be based on the earlier Shaheen 1 design, using a new motor assembly as the first stage, and using a modified second stage similar in shape to the Shaheen 1 missile. This missile may have been based upon the earlier Chinese two-stage solid propellant missile M-18, which was exhibited in 1988. The maximum range of the Shaheen 2 missile is 2,500 km, sufficient to be able to reach any target in India. Shaheen 1 is believed to be a scaled-up version of the Chinese M-11 (DF-11, CSS-7) missile, and the DF-11 entered service in China around 1992. There were reports that Pakistan received 34 M-11 missiles from China in 1993, and that a production facility was built in Pakistan. Details on the Chinese M-11 and Shaheen 1 missiles can be found in separate entries.

It is reported that the Shahine 1 and 2 missiles have been developed by the Pakistan National Development Complex (PNDC) with assistance from SUPARCO, the Pakistan space research organisation, and from the Atomic Energy Commission. Following the Pakistan nuclear warhead tests in May 1998, when it is believed that between three and six warheads were detonated, it is expected that a 15 to 35 kT nuclear warhead will be fitted into the Shahine 1 and 2 missiles. There was a possible flight test of Shaheen 1 in July 1997, although other reports described this as a test of a Hatf 3 missile. Ground motor tests for Shaheen 1 were made in 1997 and 1998, and it is possible that a ground test in 1999 was made for the new first stage Shaheen 2 motor. The TEL vehicle displayed with the Shaheen 2 missile in March 2000 was similar to the Russian MAZ-547V that had been used with the Russian SS-20 'Saber' missile system, and could carry a much heavier missile than Shaheen 2. A similar vehicle has been developed in China for use with the DF-31 road mobile ICBM. There are unconfirmed reports that a Shahine 3 missile, with a range of 4,000 km, may be in development with a dual role for use as a ballistic missile and as a satellite launch vehicle.

Description

The Shaheen 2 missile has a length of 17.0 m, a body diameter of 1.4 m, and a launch weight of 25,000 kg. The first stage length is 7.0 m, with a body diameter of 1.4 m, and a weight of around 14,000 kg. This first stage is a modified Shaheen 1 motor assembly, carrying around 10,400 kg of HTPB solid propellant. There are four clipped delta wings at the rear of the first stage. The second stage has a length of 10.0 m, a body diameter of 1.4 m, and a weight of 11,000 kg. It is believed that this stage is similar to Shaheen 1 in shape, and that the motor assembly has some 7,200 kg of HTPB solid propellant. There are four clipped delta wings at the rear of this stage, similar to those on the first stage.

The payload assembly separates from the second stage after second-stage burn-out or before re-entry, has a length of 4.2 m and a base diameter of 1.4 m. At the rear of the payload assembly there are four small SM-03 solid-propellant motors, each with a weight of 1.8 kg, which can be used to orientate the payload after boost burn out or before re-entry to improve the accuracy. The four small fins on the payload assembly would possibly provide stabilisation near the target, although it is possible that an INS/GPS guidance system has been included and that the small fins provide control in the lower atmosphere after re-entry.

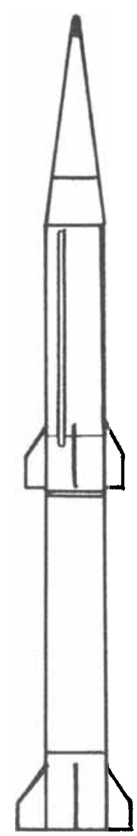
The payload assembly has a total weight of 1,050 kg with a 750 kg warhead, believed to be nuclear with a yield of between 15 and 35 kT. There are reports that alternative HE, chemical, fuel-air explosive and submunition warheads have been developed. Guidance is inertial and there may be terminal guidance. An accuracy of 350 m CEP has been reported. The minimum range is probably around 500 km, and the maximum range is stated to be 2,500 km. An unconfirmed report in 2002 suggested a maximum range of 3,500 km, but this is thought to be unlikely.

The Transporter-Erector-Launcher (TEL) vehicle displayed in March 2000 appeared to be similar to the Russian MAZ-547V TEL used with the SS-20 'Saber' missile in the early 1980s. The SS-20 missiles were destroyed following the 1987 INF treaty, but the vehicles could have been retained for other uses. A Chinese version of this TEL has been developed for use with the DF-31 system, and it is possible that the development has been shared between Pakistan and China. The wheeled TEL has six axles and is believed to have a length of 16.5 m, a width of 3.0 m, and a height unloaded of 3.1 m. The TEL has a diesel engine, probably a V58-7-MS type, providing a road speed of around 50 km/h. The missile is raised vertically for launch, with the TEL vehicle stabilised by four or six hydraulic jacks. A launch could be expected within 5 to 10 minutes of arrival at a pre-surveyed site. Also displayed in March 2000 was a missile reloading vehicle, which appeared similar to the TEL, but with a strengthened rear chassis and a crane. It is expected that both vehicles will have a road speed of around 50 km/h, and a radius of action of around 500 km.

Operational status

The Shaheen 2 missile development programme probably started around 1996, and has followed closely behind that for

A Shaheen 2 missile mounted on its TEL vehicle, displayed in November 2000 (Andrew Koch) NEW/0114346



A Shaheen 2 line diagram NEW/0114344

Shaheen 1. There has been one flight test for the Shaheen 1 missile, made in April 1999 over a range of 450 km. Shaheen 2 was first displayed in March 2000, and has not yet been flight tested. It is possible that a limited production of 5 to 10 missiles has already started, although with the close relationship between the two Shaheen missiles the precise numbers may be difficult to establish. It was reported that a flight test was being prepared in April 2002, but that this was delayed following a request from the USA.

Specifications

Shaheen **2**
Length: 17.0 m
Body diameter: 1.4 m
Launch weight: 25,000 kg
Payload: Single warhead 1,050 kg
Warhead: 750 kg nuclear 15 to 35 kT, HE, chemical, FAE or submunitions
Guidance: Inertial
Propulsion: Two-stage solid propellant
Range: 2,500 km
Accuracy: 350 m CEP

Contractors

The prime contractor is believed to be the Pakistan National Development Complex, Islamabad, with assistance from SUPARCO and the Atomic Energy Commission.

FROG-7 (9M21/52, R-65/70 Luna-M)

Type

Short-range, road-mobile, solid-propellant, single-warhead, unguided rocket.

Development

Free Rocket Over Ground (FROG) was the NATO name given to this first-generation Russian rocket, first developed in the 1950s. There have been at least six versions in service, known by NATO as FROG-1/2/3/5/7A and 7B; these have been named Filin, Mars, Luna, Luna-I and Luna-M in Russia. The first FROG-I rockets, 3R-2 Filin, entered service in 1955 with a single first-generation nuclear warhead. FROG-2, 3R-1 Mars, entered service at about the same time as FROG-I and carried a smaller nuclear warhead. FROG-3, Luna (3R-9). entered service in 1961 and was an improved version of the smaller FROG-2 missile, but with a range increased from 18 to 45 km and an HE warhead. The Luna rocket was part of the 2K6 system. FROG-5, 3R-10 Luna-2, entered service in 1963 with a nuclear warhead. The FROG-7, 3R-11 Luna-M (9M21/9M52) was the last of these unguided rockets in the family, and entered service in 1965. An alternative designator for FROG-7A was R-65 and for FROG-7B was R-70 A Luna-M2 version was developed, intended to be a more accurate rocket, but the results were relatively unsuccessful and this version did not enter production The FROGs remained in service in the former Soviet Union until the late 1980s and several modifications were made over the years Most of the FROG-7s were replaced in the Soviet Union (now Russian Federation) by the more accurate SS-21 'Scarab' short-range ballistic missile, but it is reported that some FROG-7 were used in 1999, and some may remain in storage.

Description

The FROG-I was 10 37 m long, had a diameter of 0.61 m, a launch weight of 4,930 kg and a warhead weight of 1,200 kg. The rocket had a single nuclear warhead and a range of 25 km The launch vehicle was a tracked tank chassis

FROG-2 was a smaller and lighter missile than FROG-I The length was 9.04 m, the diameter was 0 32 m, and the launch weight was 1,760 kg. This rocket had a 565 kg nuclear warhead and a range of 18 km The launch vehicle was a modified light tank chassis

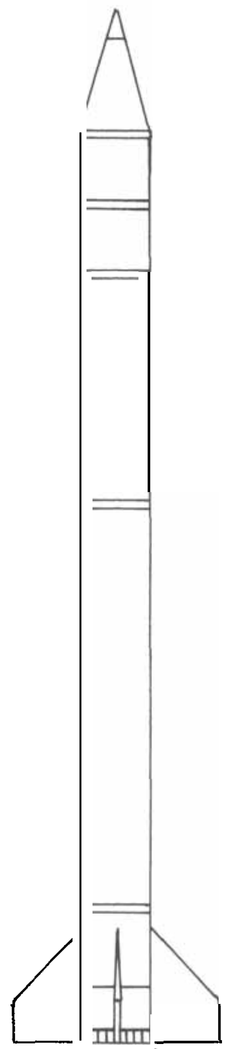
FROG-3 was 9.1 m long, had a body diameter of 0.42 m and a launch weight of 2,175 kg. This missile had a 358 kg high explosive warhead, and a maximum range of 45 km.

FROG-5 was 10.6 m long, had a body diameter of 0.54 m and a launch weight of 2,287 kg. This missile had an improved 3N14 nuclear warhead with a weight of 503 kg, and a maximum range of 32 km. It is believed that this warhead had a selectable yield varying from 20 to 100 kT.

FROG-7 is 9.4 m long, although some warheads result in shorter total lengths varying from 8.95 to 9.4 m. The body diameter is 0.54 m, fin span 1.7 m and the launch weight varies from 2,450 to 2,485 kg depending on the warhead type. The 3Kh18 solid-propellant motor contained 1,080 kg of propellant, giving the rocket a maximum velocity of 1.2 km/s. The rockets are unguided but spin stabilised, with four small spin motors located behind the warhead assembly. The accuracy is reported to be 700 m CEP, but unconfirmed reports suggest that 1,200 to 2,000 m CEP was more realistic at the maximum range. FROG-7A (R-65) is 8.95 m long and FROG-7B (R-70) is 9.4 m

A FROG-7 rocket being raised ready for launching

FROG-7 unguided rocket on its eight-wheel 9P113 TEL vehicle



A line diagram of the unguided FROG-7 rocket

long, with the addition of air brakes to provide a shorter minimum range. The FROG-7 rockets were fitted with at least six alternative warheads; AA-22 nuclear with three yields between 3 and 20 kT, AA-38 nuclear with three yields between 3 and 20 kT, AA-52 nuclear with four yields between 5 and 200 kT, a 9N18F unitary fragmenting high explosive, a 9N18OF submunitions warhead with 42 submunitions each with 1.7 kg of HE, and a 9N 18G chemical warhead with 216 kg of VX agent. The warhead weights varied between 200 and 457 kg. The minimum range of FROG-7B is 12 km and the maximum range of both FROG-7A/-7B is 68 km.

FROG-7 uses a Barrikady Br-231 eight-wheeled TEL vehicle, based on the ZIL-135 LM chassis, designated 9P11. This TEL has a length of 10.7 m, a width of 2.8 m, and a loaded weight of 17,560 kg. The TEL has 360 HP diesel engine, a crane for reloading, can travel at 60 km/h on roads, and has a crew of four. It takes about 30 minutes to set up and launch a rocket.

Operational status

The FROG-7 rocket entered service in 1965 and was extensively deployed in the former Soviet Union (Azerbaijan, Belarus, Georgia, Kazakhstan, Russian Federation and Ukraine), Bulgaria, Czech Republic, Hungary, Poland and Slovakia and exported to Afghanistan, Algeria, Angola, Cuba, Egypt, Iraq, North Korea, Libya, Serbia, Syria and Yemen. It is believed that Russian production ceased in 1972. Egypt exported some FROG-7 rockets to North Korea in 1975, and the North Koreans reverse engineered these rockets and started their own manufacture from 1979 to 1983. Despite the introduction of the SS-21 'Scarab' into the Russian Army from 1976 onwards, reports in 1994 indicated that 350 FROG-7 launchers and approximately 1,450 rockets still remained in service.

A small number of FROG-7 missiles are believed to have been used by Egypt and Syria in 1973, by Iraq against Iran in 1980, and by Iraq in the 1991 Gulf War, although it is possible that the Iraqi missiles used were the Layth variant of FROG-7. Layth is an Iraqi modified FROG-7 with a submunitions warhead and a range extended to 90 km.

Many FROG-7 missiles are reported to have been fired in Afghanistan over the period 1984 to 1999, but are believed to have been relatively unsuccessful. It is reported that HE warheads, submunition warheads and even possibly chemical warheads were used in Afghanistan against towns, villages, staging areas and main lines of communication. There have been reports of FROG-7 being fired by Serbian forces in the former Yugoslavia in 1993-1994, by the Russians in Chechnya in 1996 and 1999, and that some 20 rockets were sold to Angola in 1999.

Specifications

FROG-7B
Length: 9.4 m
Body diameter: 0.54 m
Launch weight: 2,450 to 2,485 kg
Payload: Single warhead; 200 kg to 457 kg
Warheads: HE, chemical, submunitions or nuclear (3-200 kT)
Guidance: Unguided
Propulsion: Solid propellant
Range: 68 km
Accuracy: 700 m CEP

Contractor

Not known.

SS-I 'Scud' (R-11/8A61/8K11, R-11FM (SS-N-1B) and R-I7/8K14)

Type

Short-range, road-mobile, liquid-propellant, single-warhead ballistic missiles.

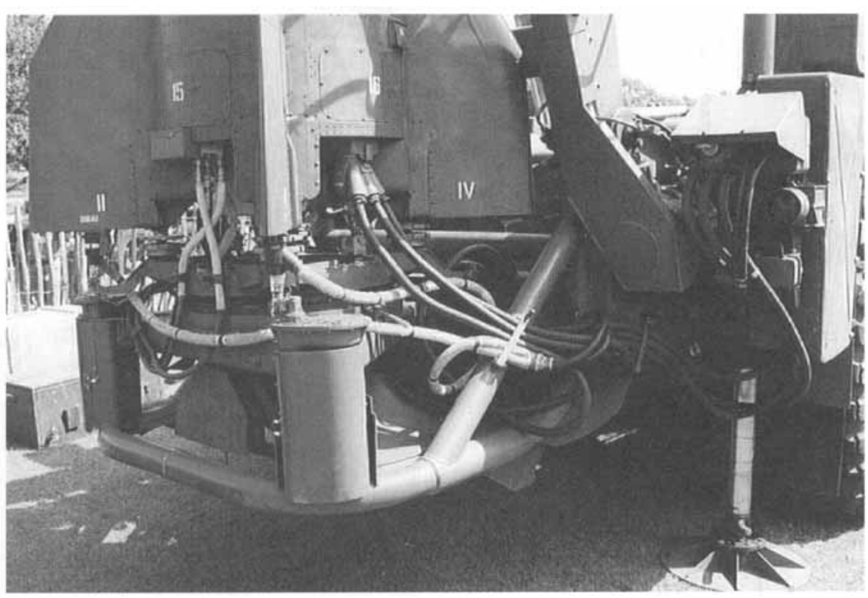
Development

The initial design of the 'Scud'was made in Russia by the Korolyev Design Bureau (OKB-1), which started work shortly after the Second World War using German V2 designs, and some of the engineers and scientists from the German weapons programme. The SS-1B 'Scud A entered service in 1955 and was known as the R-11 (8A61) missile by the Russians. The R-11M version was fitted with a nuclear warhead, and had the designator 8K11. An improved version, known as R-17 (8K14) by the Russians, and SS-1C 'Scud B' by NATO, entered service in 1962. Initially, this version was carried on the same tracked vehicle as its predecessor, but by 1965, the four axle eight-wheeled Transporter-Erector-Launcher (TEL)vehicle MAZ 543 P had been introduced and was to become the standard TEL for the 'Scud' system. Several different warheads were developed for the 'Scud B' missiles including nuclear, chemical and conventional high explosive. The plan to replace the series with the SS-23 'Spider' was abandoned as a result of the 1987 Intermediate-range Nuclear Forces (INF) agreement.

There are reports that the Russians designed two further 'Scud' variants, known as the SS-1D 'Scud C' and SS-1E 'Scud D'. The 'Scud C' is believed to have had its range increased to 550 km, but with a reduced warhead weighing 600 kg that separated from the motor and fuel tank assembly following motor burnout. This was thought to have increased stability and improved accuracy. The 'Scud D' design is believed to have been an attempt to improve the accuracy of the system to around 50 m Circular Error of Probability (CEP), using digital scene matching, with a TV camera to refine the aim point as the missile approaches the target area. Tests of a prototype 'Scud D' with a redesigned warhead section were first carried out in 1979, and a development programme was effected by the Central Research Institute of Automatics and Hydraulics (TsNIAG). The warhead section contained a TV camera in the nose, an inertial guidance system, and four paddle type control fins at the rear. A successful design was completed in 1989, but it is believed that this system did not enter service in Russia. There are further unconfirmed reports that the Russians designed a fifth variant, 'Scud E', with a range of 900 km, but this did not enter production.

A submarine-launched version, known as R-11FM (SS-N-1B 'Scud'), was developed from 1950 as a joint programme by the Korolyev and Makeyev design bureau. This missile had the designator 8K11, and was similar to the nuclear warhead version R-11M. The first flight test, from land, was made in 1955,

A Scud B' battery command and control vehicle, with a missile raised to the launch position located behind



The rear launch platform of the MAZ 543 TEL vehicle lowered to the launch position (Bob Fleming)

0003140

and the first submarine launch was made in September 1955, with a range of 250 km. The missile became operational as the D-1 SLBM system in 1959 on a project 611 'Zulu' class submarine.

Description

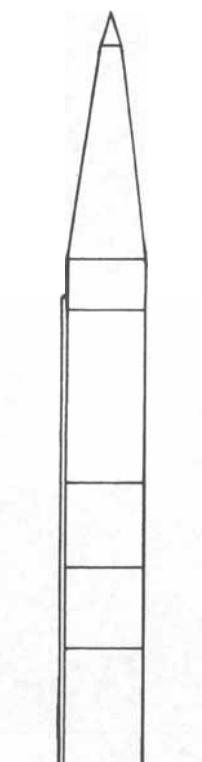
The first of the 'Scud' family of missiles, the SS-1B 'Scud A (R-11) was 10.3 m long, had a body diameter of 0.88 m and a launch weight of 5,400 kg. The missile used kerosene and nitric acid for propellant, pressurised by air. This resulted in a missile with a range of 190 km but with a CEP of around 3 km. The 'Scud A, was carried on a tracked vehicle, derived from the JS 2 tank chassis, which served as a TEL platform for the missile. A nuclear warhead version, designated R-11M, was developed and is believed to have had a yield in the 50 kT range. This version had a weight of 5,500 kg, a 600 kg payload, a range increased to 270 km and an accuracy of 6 km CEP.

The 'Scud B' (R-17) was a considerable improvement over the earlier A version. The missile is 11.25 m long, has a body diameter of 0.88 m and a launch weight of 5,900 kg. The propellants were changed, from 'Scud A', to Unsymmetrical DiMethyl Hydrazine (UDMH) and Inhibited Red Fuming Nitric Acid (IRFNA), which were fed to the combustion chamber by fuel pumps and gave a more consistent thrust. The total propellant weight at launch was around 3,130 kg and the single motor developed 130 kN of thrust at sea level.

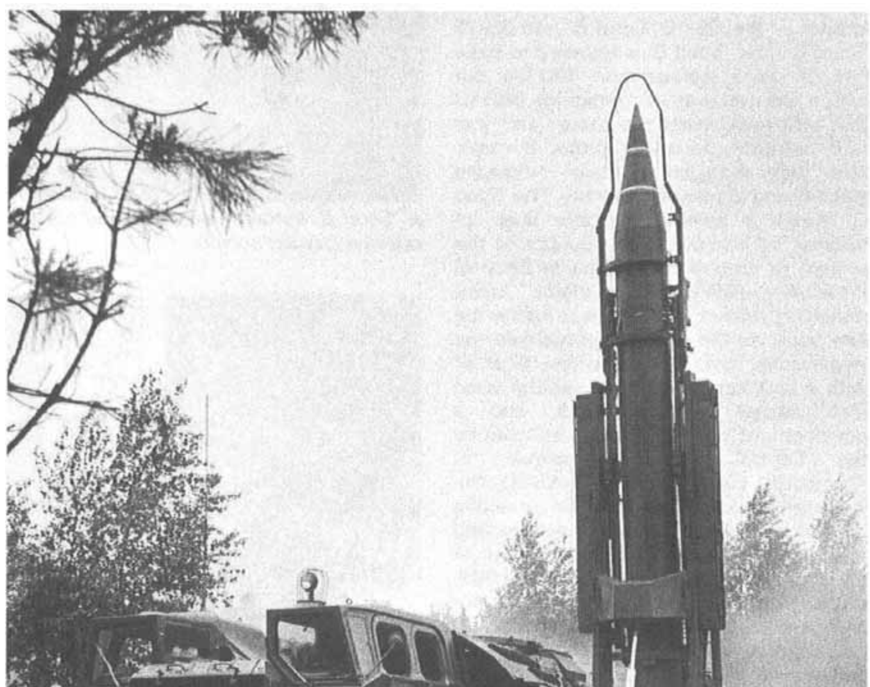
A MAZ 543 'Scud B' Transporter-Erector-Launcher (TEL) vehicle (Bob Fleming) 0003139

The structural weight, less the payload/warhead bay was 1,785 kg. These improvements increased the missiles range to 300 km and reduced the CEP to around 450 m. Guidance is by a rudimentary inertial system using three gyroscopes, which give control signals to four graphite vanes in the motor exhaust to adjust the flight path of the missile during the climb following launch. The control vanes are only operative for the period of motor burn, the first 60 seconds or so of flight.

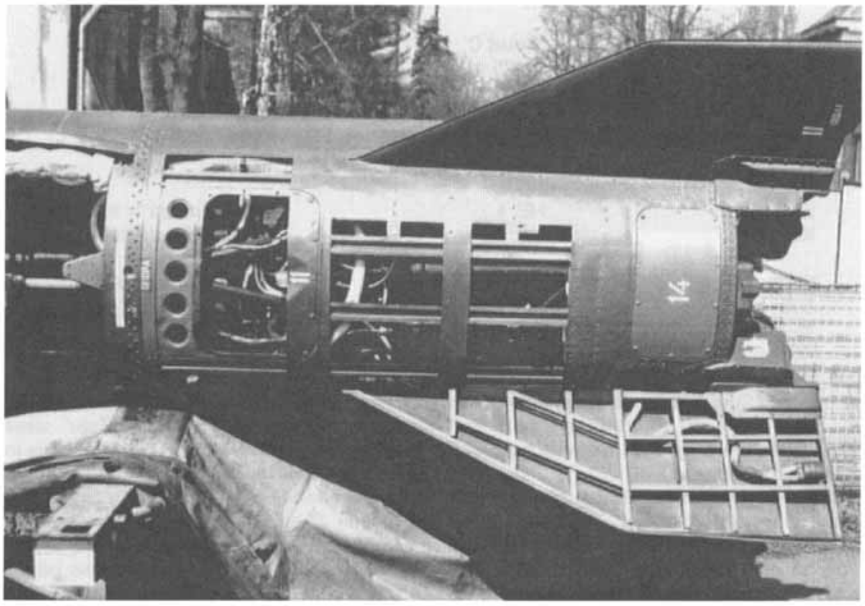
Several different warheads were developed for the 'Scud B' missiles, including nuclear, chemical and conventional high explosive. The warhead bay of the 'Scud B' is 2.87 m long forming the nose section of the missile, and weighs 985 kg. It is believed that the first Russian design for 'Scud B' was for a nuclear warhead with a yield of 50 kT, but this was later replaced with a selectable yield warhead covering from 5 to 70 kT. A diagram of a chemical warhead for the 'Scud B' shows a nose-mounted fuze with a high-explosive bursting charge to open the warhead and allow the resulting air flow to disperse the 555 kg of viscous VX chemical agent into a dense aerosol cloud. Russian documents suggest that a number of different conventional high explosive warheads were developed, including blast/fragmentation, earth penetration, fuel-air explosive and submunitions. The HE blast fragmentation warhead contains 545 kg of HE. For the submunitions, there were again several options, including: fragmentation; armour-piercing; runway penetrators; smoke; mines or incendiary. The submunitions warheads would all have been initiated by proximity fuzes, to create an airburst to deploy the submunitions over a wide area. It is believed that 40 runway penetrator submunitions were carried, each penetrator weighing 12 kg and with 3 kg of HE. Fragmentation submunitions are believed to have numbered about 100 per warhead, each weighing 5 kg and containing 1.2 kg of HE, with a damage radius between 160 and 250 m.



A line diagram of the SS-1C 'Scud B' missile



A MAZ 543 TEL vehicle with a Scud B' missile raised for launch (TASS) 0003138



This cutaway rear end 'Scud B' shows from left to right; the fuel tank, the fuel pump and compressed air reservoirs, the motor combustion chamber and the rear control valves. The traditional aircraft type construction in both body and tailfins can be seen well in this picture

The 'Scud **B'** missile is carried on an eight-wheeled MAZ 543 P TEL vehicle (9P117M), and the missile is raised to the vertical position at the back of the TEL before launch. The TEL has a length of 13.36 m, a width of 3.02 m and weighs 37,400 kg when loaded with a missile. The TEL can carry three crew, but it is believed that five men are required in the launcher crew. The vehicle has built-in test equipment, can aim the missile and can fire autonomously if required. However, the target selection and firing is usually carried out from a separate command and control vehicle. The MAZ 543 vehicle has a D-12 diesel engine rated at 525 hp, with four driven axles, and a separate 10 kW electric generator for the missile operations. Two hydraulic pumps power the cradle that raises the missile to the vertical, which takes about 4 minutes. The TEL can be adjusted to carry different missiles, by altering the roof assemblies and the cradle. Iraq used the MAZ 543 to carry the larger Al Hussein missile. A typical 'Scud **B'** launch sequence takes about 1 hour. The TEL vehicle has an unrefuelled range of 650 km on hard roads and a maximum road speed of 55 km/h. After launch, the TEL moves to a new position to avoid a counterattack and is reloaded from a towed re-supply trailer.

'Scud C' is the same size as the 'Scud B' but is believed to have had the range increased to 550 km, achieved by reducing the warhead to 600 kg and increasing the fuel and oxidant. The weight of 'Scud C' is believed to be 6,500 kg. The warhead separates from the motor and fuel tank assembly following motor burnout; this would have reduced the instability of the total missile on re-entry to the lower atmosphere, and should have improved the accuracy.

The 'Scud D' design is believed to have been a further attempt to improve the accuracy of the system to around 50 m CEP, using a digital scene-matching technique with a TV camera in the nose of a modified warhead section. The warhead separated from the missile body and had a stabilisation and guidance computer, operating four paddle-type control fins similar to those used on the SS-21 'Scarab' missile. The separating warhead section was about 4 m long and had a body diameter about 0.65 m. The overall missile length was increased to 12.29 m and the launch weight to 6,500 kg. The 'Scud D' is thought to have the same 300 km range as the 'Scud B'.

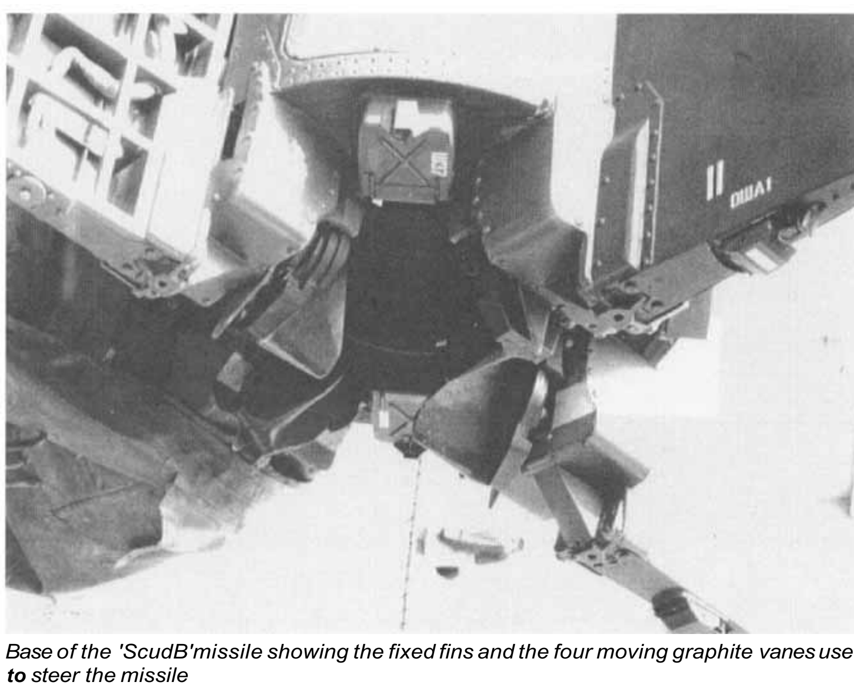
The naval submarine-launched version of the 'Scud A', known as R-11FM or SS-N-1B 'Scud', had a length of 10.34 m, a diameter of 0.88 m and a launch weight of 5,465 kg. The empty weight was 1,677 kg, the warhead bay weighed 985 kg and around 2,805 kg of propellant was carried. The maximum range was reported as either 150 or 250 km. Two missiles were carried in a 'Zulu' class boat, with the missiles located vertically in the sail. The missile could only be launched with the submarine on the surface. This missile carried a nuclear warhead, believed to have a yield of 50 kT.

Operational status

The 'Scud A' entered service in 1955, the R-11M nuclear warhead version entered service in 1958. These were then replaced by the SS-1C 'Scud **B'** missile starting in 1962. By 1965, 'Scud B' was operational in many countries throughout Europe and the Middle East. 'Scud **B'** missiles were used by Egypt in 1973 against Israel, but only a small number were fired. A large number, in excess of 600, 'Scud **B'** and North Korean 'Scud **B'** variants were fired by both Iraq and Iran during their eight years war between 1980 and 1988, and over 2,000 'Scud **B'** and possibly a small number of 'Scud C' are believed to have been used in Afghanistan. A small number of 'Scud' missiles were used in the civil war in Yemen in 1994, and by Russia in Chechnya in 1996.

More than 700 'Scud' launchers were deployed by the former Warsaw Pact nations, each launcher carried one missile and had three reloads available. 'Scud B' missiles have been exported to Afghanistan, Azerbaijan, Belarus, Bulgaria, Czech Republic, Egypt, Georgia, Hungary, Iran, Iraq, Kazakhstan, North Korea, Libya, Poland, Romania, Slovakia, Syria, UAE, Ukraine, Vietnam and Yemen. Reports indicate that 'Scud **B'** missiles have been withdrawn from service in Belarus, Czech Republic, Hungary, Poland and the Russian Federation.

Unconfirmed reports between 1996 and 2000 have suggested that 'Scud B' missiles may have been purchased by Armenia, Democratic Republic of the Congo, Ecuador, Pakistan, Peru; and Sudan, but these might have been built in the former Soviet Union or elsewhere. Around 30 'Scud **B'** missiles and four TELs



*Base of the 'Scud B' missile showing the fixed fins and the four moving graphite vanes used **to** steer the missile*

Specifications

	R-11 'Scud A'	R-17 'Scud B'	'Scud C'	'Scud D'
Length	10.3 m	11.25 m	11.25 m	12.29 m
Body diameter	0.88 m	0.88 m	0.88 m	0.88 m
Launch weight	5,400 kg	5,900 kg	6,400 kg	6,500 kg
Payload	Single warhead; 950 kg	Single warhead; 985 kg	Single warhead; 600 kg	Single warhead; 985 kg
Warheads	Nuclear 50 kT, or HE	HE, Chemical or Nuclear 5-70 kT	HE	HE, chemical or nuclear
Guidance	Inertial	Inertial	Inertial	Inertial with digital scene matching
Propulsion	Single stage liquid	Single stage liquid	Single stage liauid	Single stage liauid
Range	190 km	300 km	550 km	300 km
Accuracy	3,000 m CEP	450 m CEP	700 m CEP	50 m CEP

were purchased by the USA in 1995, and the missiles were converted into targets by Lockheed Martin under the 'Willow Sand' programme. The first two target missiles were launched in 1997 at the South Pacific range. It is estimated that several thousand 'Scud' missiles were built in Russia, maybe as many as 7,000, and reports indicate that 'Scud B' missiles and improvements have been manufactured in Egypt, Iran, Iraq, North Korea and Syria. As a result it is often difficult to identify the source of any missile supplies.

Although there was a great deal of media coverage on the use of 'Scuds' by Iraq during the Gulf War in 1991, the missiles used were largely the Iraqis' own improved 'Scuds', the Al Hussein. It was reported that 32 'Scud C' missiles and eight TELs were sold to Armenia between 1993 and 1996.

A Russian report in 1998 suggested that there were four 'Scud B' TEL and around 100 missiles in Afghanistan, some with the Taliban and some with Massoud's forces, and that these could be passed on to terrorist organisations. Ukraine was reported to have three brigades with 'Scud B' missiles in 1998, and a total of 55 missiles in service. In 1999 Libya paraded some 20 refurbished 'Scud B' TELs with missiles, possibly following assistance from North Korea. Bulgaria took 47 missiles and 12 TELs out of service in 2001.

The naval 'Scud A SLBM (R-11FM) entered service in 1959 on 'Zulu' class submarines, but was taken out of service in 1968 and replaced by longer range systems (SS-N-4and SS-N-5 'Sark). It is believed that a single 'Zulu' class submarine, together with 'Scud A R-11FM missiles were sold to China in 1959 and that the Chinese began to reverse engineer the design but abandoned this in 1961. There are no confirmed reports that Russia produced 'Scud C' , 'Scud D' or 'Scud E' designs, or that these missiles ever entered service.

Contractor

The SS-1 Scud family was designed by the Korolyev Design Bureau (OKB-1).

SS-18 'Satan' (RS-20/R-36M/15A14/15A18)

Type

Inter-continental-range, silo-based, liquid-propellant, Multiple Independently targetable Re-entry Vehicle (MIRV)-capable ballistic missile.

Development

The SS-18 has the Russian designation RS-20 and has the identification numbers 15A14 (RS-20A) for the Mod 1 and Mod 2 versions, 15A18 (RS-20B) for the Mod 3, and 15A18M (RS-20V) for the Mod 4 version. The SS-18 was also given the Russian designator R-36M, to indicate that it was derived from the earlier R-36 (SS-9 'Scarp') ballistic missile. As with the smaller SS-17 and SS-19, the SS-18 was an evolutionary development of an existing missile, the SS-9; this latter missile being used as the development vehicle for the MIRV technology to be incorporated on the SS-18. Development of the SS-18 began in 1964, with the first version being deployed in 1975 with eight warheads. A modification 2 version was deployed in 1978 with a single warhead. A third version, Mod 3, with ten warheads and a greater range was introduced in 1980, and the fourth version, Mod 4, with ten warheads and improved accuracy was introduced in 1988.

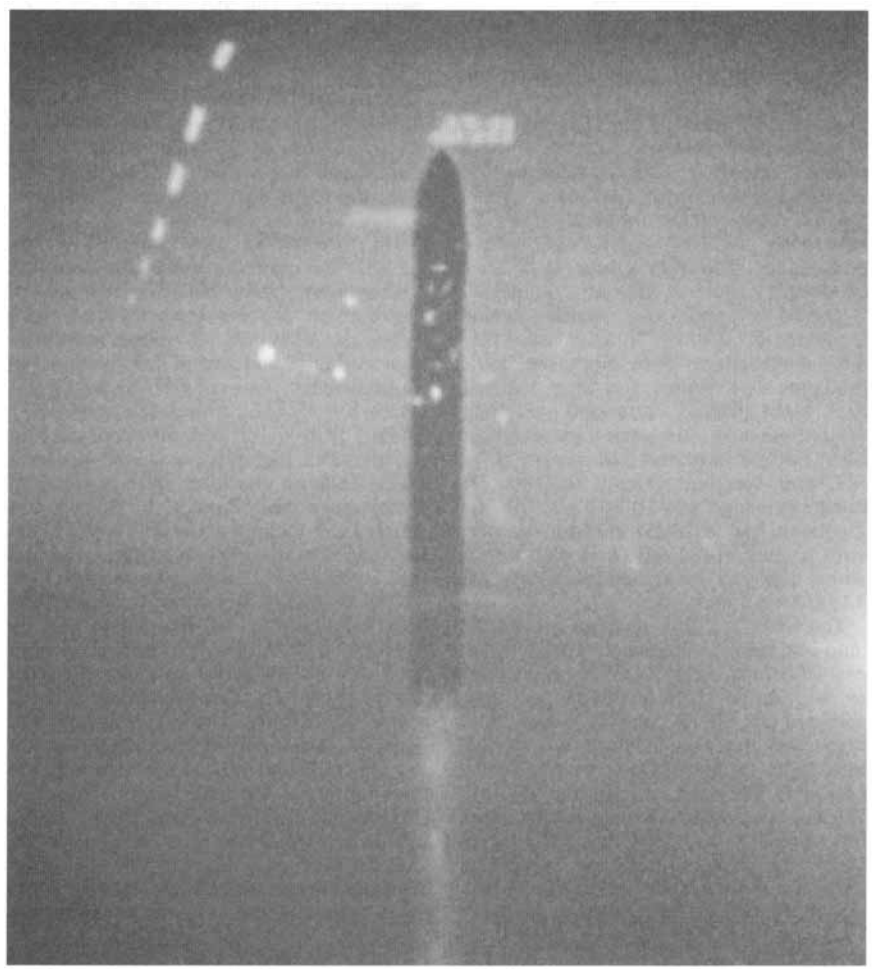
Under the Strategic Arms Limitation Treaty (SALT) terms, the SS-18, was classed as 'heavy', as was the US Titan missile. The terms of the SALT 2 Treaty allowed modernisation of missiles in this 'heavy' category, but new missiles were not permitted, and SALT 2 allowed a maximum of 820 land-based Inter-continental-range Ballistic Missiles (ICBMs), of which no more than 308 may be of the 'heavy' SS-18 category. Early flight tests of the modification 4 (10 MIRV) version SS-18 missile did not prove successful. The first launch, in April 1986, exploded soon after clearing the silo and another launch in September 1986 ended when an explosion occurred during the separation of the first and second stages.

Tests in the later 1980s were made using a single RV, and this version was believed to be Mod 5, although it could have been a Mod 2 version. It is believed that the Russians had a continuing interest in a missile with one, very powerful warhead. These single warhead tests may have been part of a comparative test programme, designed to establish the best way of countering the improved hardness of modern silos, given that single warhead missiles have a greater accuracy and hard target capability than MIRV systems.

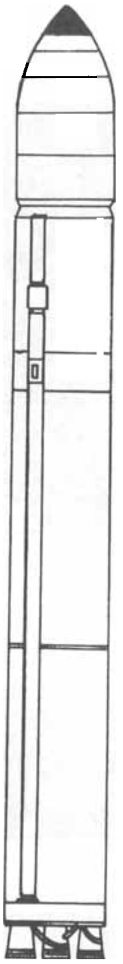
Description

The SS-18 is the largest of the 'fourth-generation' Russian inter-continental ballistic missiles and the only 'heavy' missile permitted under the SALT 2 Treaty. It is a two-stage, liquid-propelled missile. SS-18 Mods 1 and 2 are 33.6 m long and 3 m in diameter. It is believed that the first stage uses the four-motor RD-251 propulsion system producing 460 tonne thrust, and the second stage uses the single motor RD-0229/0230 system

The nose assembly of an SS-18 missile (Duncan Lennox)



An SS- 18 'Satan' ICBM just after launch (Duncan Lennox)



A line diagram of an SS-18 missile 0038258

producing 77 tonne thrust. The first stage is controlled by deflecting the motor nozzles, and the second stage by four vernier motors. Both first and second stages use Unsymmetrical Dimethyl Hydrazine (UDMH) and N_2O_4 liquid propellants. The bus motor is a solid-propellant motor. Launch weight is 210,000 kg and the throw weight (payload) is 7,200 kg. These missiles have inertial navigation with digital computer guidance and control. The Mod 1 missile had eight MIRVs, arranged externally around the nose, and carried some decoys. Each nuclear warhead had a yield of 1.3 MT, and weighed around 900 kg. The maximum range was 10,200 km. The Mod 2 version had a single nuclear warhead with a yield of 24 MT, and also carried some decoys. The maximum range was 11,000 km.

The Mod 3 and 4 versions are 34.3 m long and have an increased launch weight of 217,000 kg. Improvements were made to the range and accuracy for these versions of SS-18, and a wider MIRV dispersed area. The payload bus has the ten MIRVs mounted in two rows within the assembly. The payload weight is 8,800 kg. The second stage has been modified and the engines are single motor RD-0256/0257. The bus motors are liquid propellant using the same propellants as the first *two* stages. The Mod 3 has ten MIRV each with

Specifications

	SS-18 Mod 1	SS-18 Mod 2	SS-18 Mod 3	SS-18 Mod 4
Length	33.6 m	33.6 m	34.3 m	34.3 m
Body diameter	3.0 m	3.0 m	3.0 m	3.0 m
Launch weight	210,000 kg	210,000 kg	217,000 kg	217,000 kg
Payload	8 × MIRV	Single warhead	10 × MIRV	10 × MIRV
Warheads	Nuclear 1.3MT	Nuclear 24MT	Nuclear 500 to 550 kT	Nuclear 500 to 750 kT
Guidance	Inertial	Inertial	Inertial	Inertial
Propulsion	2-stage liquid	2-stage liquid	2-stage liquid	2-stage liquid
Range	10,200 km	11,000 km	15,000 km	15,000 km
Accuracy	n/k	n/k	920 m CEP	500 m CEP

a yield of 500 to 550 kT, carries some decoys, and has a maximum range of 15,000 km. The accuracy is 920 m CEP. The Mod 4 version also has 10 MIRVs, each with a 500 to 750 kT nuclear warhead, and a maximum range of 15,000 km. The Mod 4 version has improved protection against nuclear bursts, improved accuracy and better reliability. The Mod 4 version has an accuracy of 500m CEP. The Russians declared both 1 and 10 RV versions for the STrategic Arms Reduction Treaty (START) data exchange in 1991, believed to be Mod 1, 3 and 4 versions, together with a throw weight of 8,800 kg for the SS-18. Subsequent data indicates that the payload bay is 8.0 m long.

Like other fourth generation ICBMs, the SS-18 is deployed in a launch canister within the silo to provide environmental protection to the missile during transportation and silo loading. The missiles can remain fuelled and on alert for several years. The missile has a life of 22 years, but in 1999 it was reported that this life was to be extended to 24 years.

Operational status

The SS-18 was deployed operationally in 1975 in former SS-9 silos and launch complexes converted and improved to accommodate the larger SS-18 missiles. The Mod 2 version was introduced in 1978, the Mod 3 in 1980 and the Mod 4 in 1988. The number of SS-18s deployed was estimated to be 308, the 1991 level of deployment for this system. In 1991, there were six major SS-18 operational sites, four in Russia and two in Kazakhstan. The Russian sites were at Dombarovsky (64 silos), Kartaly (46). Aleysk (30) and Uzhur (64). The two Kazakhstan sites were at Derzhavinsk (52 silos) and Zhangiz-Tobe (52). Training facilities were located at Balabanovo and Panerki in Russia and testing was located at Leninsk with 10 test silos. Missile storage was at Pibanshur and Khrizolitovy, with 58 missiles in store.

The START 1 agreement required the SS-18 missiles to be reduced to 154 by 2003, and the START 2 proposals require that the remaining SS-18 missiles should be removed from their silos and destroyed by 2007. START 2 was ratified by the Russian Federation in May 2000, but not by the USA, and was abandoned with the signing of the Strategic Offensive Reductions Treaty in May 2002. Some SS-18 missiles may now be retained in service, and some missiles may be used as satellite launch vehicles rather than being destroyed. In addition, it is believed that the Russians might modify some SS-18 silos to accept the SS-27 (Topol-M) missiles, but it is not known how many silos will be modified.

In December 1994, the number of operational missiles had reduced to 255, and all the Mod 1 missiles had been removed from service. By July 1996 the total had reduced to 193, and by January 1998 to 180. At January 2001, there were still 180 missiles in service, with 122 Mod3 and 58 Mod 4 standard. It is reported that all 104 missiles in Kazakhstan have been deactivated and by January 1998, all the missiles had been removed. Some of the missiles removed from Kazakhstan were the Mod 3 single warhead version. All the silos in Kazakhstan had been destroyed by September 1996. An SS-18 destruction plant has been built at Surovatikha near Nizhny Novgorod and this has the capacity to destroy around 30 missiles per year, although there are plans to increase this rate to 50 per year. The first Russian-based silos were destroyed in 2000, with six destroyed at Aleysk. By January 2002 all the missiles had been removed from Aleysk. and around 145 missiles remained in service with 52 at Dombarovsky, 46 at Kartaly and 46 at Uzhur.

A trials SS-18 launch was made in June 1995 from Baikonur, testing an 18 year old missile, and a further trial was made in April 1997 successfully testing a 20 year old missile. By January 1999, there had been 157 SS-18 missile test launches completed, with a reported success rate of 97 per cent. The Yuzhnoye NPO offered a civilianised variant of the SS-18 missile, for use as a launcher for large payloads (up to 4,000 kg) into low Earth orbit in 1991. The first launch of a converted SS-18 missile was made in April 1999, with the satellite launch vehicle named Dnepr-1, as a joint Russian Federation and Ukraine programme. The launch was made from one of four available silos at Baikonur, and there are plans to convert a further 20 to 50 missiles for use as SLVs rather than destroying them as required under the START agreements. A second missile was used to launch five satellites into orbit from Baikonur in September 2000.

Contractors

The SS-18 was designed by the Yangel Design Bureau and the missiles were built by the Yuzhnoye NPO at Dnepropetrovsk, Ukraine. All warheads are believed to have been manufactured in Russia.

SS-19 'Stiletto' (RS-18/UR-100N/15A30/15A35)

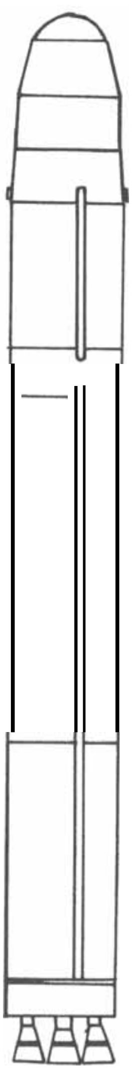
Type

Inter-continental-range, silo-based, liquid-propellant, Multiple Independently targetable Re-entry Vehicle (MIRV)-capable ballistic missile.

Development

The SS-19 has the Russian designation RS-18 and the identification UR-100N or 15A30 for the Mod 1 version, and UR-100NU or 15A35 for the Mod 2 version. The SS-19, together with the SS-17 and 18, comprised the fourth generation of Russian strategic missiles. The most important characteristic of this generation of Inter-Continental-range Ballistic Missiles (ICBMs) was the introduction of a real independent targeting capability for their multiple re-entry vehicles, making them genuine MIRV systems. The MIRV technology was first introduced by the USA in the 1960s on their Poseidon and Minuteman missiles.

The SS-19 began development in 1968 at the Chelomei Design Bureau (OKB-52) with the first flight test taking place from Baikonur in April 1973 and entering service in 1975. The improved Mod 2 version was first flight tested at Baikonur in 1977 and entered service in 1980. The SS-19 has the capability to carry up to six MIRVs.



A line diagram of an SS-19 missile 0038259

Reports from the US suggest that the SS-19 has been flight tested in a version with a single, large, re-entry vehicle, as have the SS-17 and SS-18. These versions might be intended for use against very hard targets that require high warhead yields for their destruction, but they might also have been intended initially to compensate for the lower accuracy of the early MIRV systems. Following Russian ratification of the START 2 agreement, the SS-19 missiles remaining in service were planned to be modified to carry a single warhead. However, as START 2 was not ratified by the USA and was replaced by the Strategic Offensive Reductions Treaty in May 2002, the Russians are free to decide the number of warheads to be carried by each missile.

The SS-19 is similar to the SS-17 in specification, a point which has been interpreted as evidence of insurance, *so* that there would have been at least one successful missile in the 'Minuteman' class to deploy in the 1970s. Although the reasons for the dual development of these two fourth-generation missiles are still not clear, there were distinct differences between them, which may suggest that confidence in the designs was not total, necessitating the development of both. The SS-19 is, for example, hot-launched from its silo, using its first boost stage to eject, while the SS-17, like the SS-18, used an additional boost stage or launch assist device, to cold launch from the silo. In service, the Russian Federation has clearly preferred the SS-19 design, with the SS-17 missiles all removed from service by 1996.

Description

The SS-19 Mod 1 missile had a length of 24.0 m, a body diameter of 2.5 m and a launch weight of 92,700 kg. The payload had six MIRVs, each with a weight of 340 kg and a 500 kT nuclear warhead. This version had a throw weight of 3,355 kg. The missile had two liquid-propellant stages, using Unsymmetrical Dimethyl Hydrazine and nitrogen tetroxide, and a liquid-propellant motor on the bus for the MIRVs. The first-stage engines were RD-0233/0234 with four motors, the second stage RD-0235/0236 with one motor and four vernier motors for control, and the bus motor was an RD-0237. The missile carried 17,400 kg of UDMH and 44,400 kg of nitrogen tetroxide at launch. This provided a first-stage burn time of 120 seconds, a second-stage burn of 55 seconds followed by a coasting period and then a second burn of 100 seconds, and a bus burn time of between 120 and 150 seconds. The SS-19 Mod 1 had a digital guidance and control system using inertial guidance, believed to be similar to the system in the SS-18 'Satan' missiles. The missile had a range of 9,000 km and an accuracy of 550 m CEP. An alternative targeting option increased the range up to 10,750 km, but with a reduced accuracy and a larger dispersal pattern of the MIRVs.

The Mod 2 version is slightly longer at 24.3 m, and heavier at 105,600 kg. In 1991, the Russians declared a throw weight of 4,350 kg and six MIRVs. The re-entry vehicles and warheads are improved versions with a yield of 500 to 750 kT each. The Mod 2 missiles have an improved guidance system, with an onboard computer, and also a reduced launch preparation time. This version has a range of 10,000 km, and an accuracy of 900 m **CEP.**

The SS-19 is transported in a protective canister and as is the case with the other fourth-generation missiles, it is also deployed in a canister within its silo. The canister has a length of 24.5 m and a diameter of 2.9 m. The missiles were deployed in a regiment of ten silos, with a command post in an additional silo. The SS-19 missile convoy uses two large articulated vehicles to move the two propulsion stages separately, and a smaller vehicle to move the payload section with its warheads. The missile had a design life of 23 years, but plans were reported in 1998 to increase the life to 30 years for the Mod 2 missiles.

Operational status

The SS-19 'Stiletto', the last of the fourth-generation land-based missiles, was flight tested with 30 trials from Baikonur between 1973 and 1975, with only three reported failures. The Mod 1 version was deployed operationally in 1975 in modified SS-11 'Sego' silos. The Mod 2 version was first flight tested in 1977 and was deployed operationally in 1980. By 1983, all the deployed SS-19 missiles were to the Mod 2 standard. The SS-19 missiles reached their peak deployment of 360 missiles in 1982 and production continued until 1990. In 1991, there were 300 missile silos at four operational sites, two in Russia and two in Ukraine. The Russian sites were at Kozelsk (60 silos) and Tatischevo (110). while the Ukraine sites were at Khemilnitsky (90 silos) and Pervomaysk (40). Training facilities were at Balabanovo and Rostov in Russia and testing was at Levinsk with two test silos. Missile storage for the SS-19 was at Kolosovo and Mikhaylenki, with 63 missiles in store. The Russians declared six MIRVs for all the SS-19s in 1991, assumed to be the Mod 2 standard. During the 1992 discussions on START 2, the Russians requested that the START 1 downloading limits be relaxed, so that they could convert some of the 170 SS-19 missiles in silos in Russia to single warhead missiles.

In December 1994, there were reported to be 274 missiles operational, but this had reduced to 235 by November 1995 with all the Ukraine missiles deactivated. A facility was built at Dnepropetrovsk in the Ukraine to destroy SS-19 missiles, which was opened in August 1996 with the capacity to destroy four missiles per month. In July 1996, there were 211 missiles operational and 297 silos and by January 1998, the numbers had reduced to 170 missiles. In January 1999, it was reported that all 130 Ukraine missiles had

been destroyed, and that there were 168 missiles remaining in the Russian Federation. By January 2000 the Russian inventory had reduced to 150 missiles, and it was reported to be still at 150 missiles in June 2001.

There were believed to be 140 missiles operational in July 2002, and some of these are expected to be retained in service with between one and six warheads each. Some 30 to 35 silos at Tatischevo are planned to be modified for SS-27 Topol-M missiles. A 20 year old SS-19 missile with six MIRVs was launched from Kazakhstan in June 1996, and tests were made in June 1997, October 1998, October 1999, November 2000, June 2001, October 2001 and December 2001. The November 2000 and October 2001 flight tests used an upgraded missile with a single warhead. It is reported that 148 test flights have been made with SS-19 missiles up to the end of 2001.

A satellite launch vehicle, using the first two stages of the SS-19 missile, has been tested with three flights from a silo at Baikonur in 1991, 1992 and 1994. The SLV was known as 'Rokot' originally, but a joint programme between Krunichev NPO (Russian Federation) and DASA (Germany) was formed in 1996 and the SLV is now known as 'Eurokot'. A third liquid stage has been added for the SLV, which is capable of up to six ignition and burn periods. The 'Eurokot' was first launched from Plesetsk in May 2000 with a demonstration payload of two dummy satellites, and will be used to put payloads of up to 1,850 kg into low Earth orbit.

A second satellite launch vehicle, also using SS-19 assemblies, was proposed by NPO Mashinostroyenia in 1995, called 'Strela', and this was planned to use a modified payload bus as the third stage to launch multiple small satellites. A first launch was proposed for 2002 or 2003.

Specifications

SS-19 Mod 1
Length: 24.0 m
Body diameter: 2.5 m
Launch weight: 92,700 kg
Payload: 6 × MIRVs
Warhead: Nuclear 500 kT
Guidance: Inertial
Propulsion: 2-stage liquid
Range: 9,000 km
Accuracy: 550 m CEP

SS-19 Mod 2
Length: 24.3 m
Body diameter: 2.5 m
Launch weight: 105,600 kg
Payload: 6 × MIRVs
Warhead: Nuclear 500 to 750 kT
Guidance: Inertial
Propulsion: 2-stage liquid
Range: 10,000 km
Accuracy: 900 m CEP

Contractor

The SS-19 was designed by the Chelomei Design Bureau (OKB-52) at Reutov, now known as NPO Mashinostroyenia or ERPA, and was built at the Krunichev Machine Production Plant No 23 at Fili near Moscow.

SS-21 'Scarab' (OTR-21/9M79 Tochka)

Type

Short-range, road-mobile, solid-propellant, single-warhead ballistic missile.

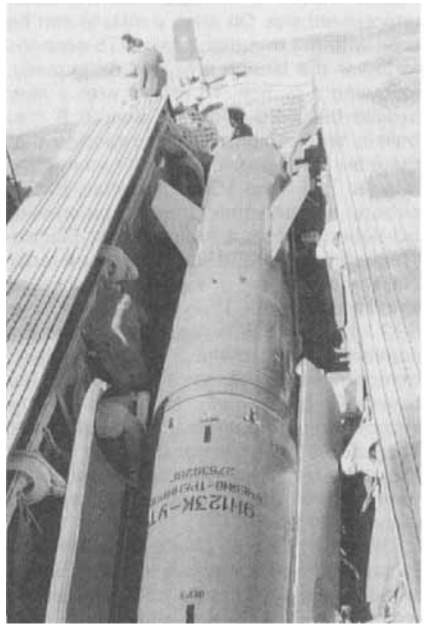
Development

The Russian designation for the SS-21 system is OTR-21 and 9K79, and for the missile is 9M79; the system name is *Tochka* (Point). The SS-21 'Scarab' was developed from 1968 to 1974 as the replacement for the short-range Free Rocket Over Ground ('FROG') missile, and was introduced into service in 1975. The design was carried out by the Kolomna OKB (also known as KBM), led by Sergei Nepobedimy, who also designed the SS-23 'Spider' (OTR-23) and SS-X-26 'Stone' missile systems. A longer-range missile, SS-21 'Scarab B', known in Russia as Tochka-U, was developed between 1984 and 1988, and entered service in 1989. A life extension programme was started in 1996, with the first flight test in 1999. There were unconfirmed reports that a further upgrade, SS-21 'Scarab C', resulted in a smaller missile with a range increased to 185 km, with two missiles being carried on a modified Transporter-Erector-Launcher (TEL). It is possible that these reports referred to a reload vehicle for SS-21, or perhaps to the development of the TEL for the SS-X-26 which carries two missiles.

Description

The SS-21 'Scarab A is a short-range missile 6.4 m long and 0.65 m in diameter. It has a launch weight of 2,000 kg with a minimum range of 15 km and a maximum range of 70 km. Propulsion is a single-stage solid propellant motor and the missile uses a TsNIIAG inertial guidance system. The control system employs four paddle type rear-mounted control fins, similar to those fitted to the SS-13 'Savage', SS-23 'Spider' and SS-25 'Sickle' ballistic missiles. These can control the missile in boost and terminal phases when within the atmosphere. In addition, vanes in the motor efflux contribute to stability immediately after launch. The paddle type control fins and control vanes are electrically actuated. The missile is reported to be able to fly either ballistic or cruise flight profiles, the latter profile uses wing lift and keeps the maximum altitude at around 30 km followed by a steep dive onto the target. Reports suggest that the 9M123F warhead has a total weight of 420 kg, with a unitary high explosive fragmentation filling, weighing 120 kg. Alternative warheads are the 9M123K submunitions and 9M79B (AA60) nuclear, and these are believed to have a weight of 482 kg. The submunitions warheads can be anti-personnel, anti-armour or anti-runway types. The nuclear warhead is believed to have a selectable yield of 10 or 100 kT. A further warhead type could be fitted, designated 9N123R, and this is an EMP warhead to damage electronic components. All warheads are reported to have a nose-mounted laser altimeter, to act as a fuze function for air bursts. Following the Intermediate-range Nuclear Forces (INF) Treaty photographs of the SS-23, it would seem quite possible that the SS-21 also has an earth penetration HE or nuclear warhead. 'Scarab A' has an accuracy of 150 m CEP.

The missile is carried on a Titan Central Design Bureau six-wheeled modified 211-5937 or BAZ 5921 transporter-erector-launcher vehicle (9P129), and the associated transloader vehicle (9T218) carries a further two missiles and a crane. The TEL vehicle weighs 18,145 kg loaded, and 16,125 kg empty, and has a crew of three. The vehicle is amphibious and is capable of driving over rough terrain.



A top view of an SS-21 'Scarab B' inissile lowered to the transportation position within the TEL vehicle (Christopher F Foss)

The maximum road speed is 60 km/h and it has an unrefueled range of 650 km. The TEL has a 5020B diesel engine with a 50 kW D-144-81 gas turbine driving an electric generator. The missile is raised to 78° elevation for launch, by a hydralically powered launch arm. The vehicle can swim at 8 km/h. Both the TEL and the transloader have Nuclear, Biological and Chemical (NBC) filter systems and decontamination systems. SS-21 missile brigades have 18 TELs each and probably 72 missiles. Additional vehicles associated with the SS-21 system are the command and control vehicle (GAZ-66), a mobile missile test vehicle (9V818), a maintenance vehicle (9V844), missile transporters (9T222) carrying two missiles, warhead transporters (9T238) carrying four warheads, a site survey vehicle (VAZ-452). an automatic test vehicle (9V818), and a meteorology vehicle. SS-21 missiles can be launched without pre-surveyed sites, but surveying requires a longer pre-launch preparation time.

The SS-21 'Scarab B (9M79-1 Tochka-U) was first exhibited by Russia in 1993, with a new motor and improved guidance and control. The size and shape are similar to 'Scarab A, the weight has increased to 2,010 kg and the maximum range has been increased to 120 km. A minimum range of 20 km was reported. This version has a maximum velocity of 1.8 km/s and a maximum dive angle of 85°. There is reported to be a terminal guidance system, probably using the Central Scientific Research Institute for Automation and Hydraulics (TsNIIAG) radar or optical (TV) correlation systems coupled to Glonass positioning system data to update the inertial navigation system. Mobile target assessment and allocation vehicles are used to provide

An SS-21 'Scarab' missile on the 9P 129 Transporter-Erector-Launcher (TEL) vehicle, on parade in Moscow in 1985

coordinates to the missiles before launch. The 'Scarab B' system can be operated with a crew of three, and can launch a missile within 16 minutes of arrival at an unprepared site. On alert, a missile can be fired within 2 minutes. It takes 75 seconds to lower the launch arm and drive away, following a launch. To reload with a new missile takes 20 minutes. 'Scarab B' has built-in test equipment. It is reported that there are six warhead options: two nuclear rated at 10 kT and 100 kT; a unitary HE; an airburst anti-personnel fragmentation with 50 submunitions; a high airburst Electro-Magnetic Pulse (EMP); and an anti-radar blast warhead for use against ground or ship radar targets. The warhead weight is 482 kg. 'Scarab B' is reported to have the capability to make preprogrammed manoeuvres of up to 10 g during the terminal phase of flight to make interception more difficult for the defence. The paddle type control fins also control the missile when the anti-radar blast warhead is used. 'Scarab B' has an accuracy of 95 m CEP.

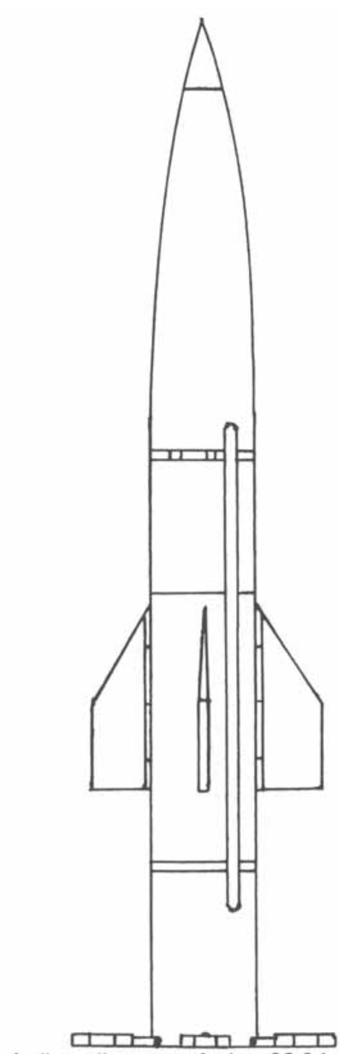
The SS-21 'Scarab C' was reported to be in development flight trials in 1989, with a smaller missile (about 1,800 kg launch weight) and a larger redesigned TEL vehicle that carries two missiles side-by-side. The 'Scarab C' version was believed to have a range increased to 185 km. However, these reports are believed to have been incorrect.

Operational status

The SS-21 'Scarab A entered service in 1975, and has been exported to Belarus, Czech Republic, Germany, Hungary, Kazakhstan, Poland, Slovakia, Syria, Ukraine and Yemen. It is believed that the missiles from Czech Republic, Germany, Hungary, Poland and Slovakia have all been removed from service. It is estimated that there are approximately 300 TEL vehicles deployed in Russia. It is believed that the Russian in-service total in 1993 was probably near to 1,200 missiles, and that production ceased in 1993. It is reported that there are 310 nuclear warheads available for the SS-21 in Russia. The 'Scarab B' version entered service in 1989. A further version was reported to have been in development called 'Scarab C', but this has not been offered for export and the programme was probably terminated in the early 1990s. A life extension programme started in 1996, to increase the 'Scarab B' life from 15 to 25 years, and this was first flight tested in October 1999. An unconfirmed report has suggested that Syria exported a small number of SS-21 'Scarab' missiles and their TELs to North Korea in 1996, for reverse engineering and technology transfer. It is believed that between 60 and 100 SRBM were used by Russia in Chechnya during 1999, and that the majority of these were SS-21 missiles with a smaller number of SS-1 'Scud B'. Flight tests of the SS-21 missile are conducted regularly in the Russian Federation, with four or five each year. A missile test in Ukraine resulted in an SS-21 missile going off course and landing in a suburb of Kiev in April 2000. It is reported that Ukraine had 500 missiles, and had tested 18 up to April 2000. Around 80 missiles are believed to have been exported to Yemen, and around 40 missiles with 12 TEL to Syria.

Specifications

SS-21 'Scarab **A'**
Length: 6.4 m
Body diameter: 0.65 m
Launch weight: 2,000 kg
Payload: Single warhead; 482 kg



A line diagram of the SS-21 **'Scarab'** *(OTR-21) missile*

A rear view of an SS-21 'Scarab B' missile on its TEL, showing the four lattice-type paddle control fins at the base of the missile (Christopher F Foss)

Warheads: HE, chemical or nuclear (10 or 100 kT)
Guidance: Inertial
Propulsion: Single stage solid
Range: 70 km
Accuracy: 150 m CEP

SS-21 'Scarab B'
Length: 6.4 m
Body diameter: 0.65 m
Launch weight: 2.010 kg
Payload: Single warhead; 482 kg
Warhead: HE, chemical, nuclear (10 kT or 100 kT) or submunitions
Guidance: Inertial with passive radar terminal option
Propulsion: Single stage solid
Range: 120 km
Accuracy: 95 m CEP

Contractors

SS-21 'Scarab' was designed by the Kolomna design bureau (KBM) and was manufactured by the Votkinsk Machine Building Plant at Udmurt and the Petropavlovsk Machinery Plant, Kazakhstan. The system is being marketed by Rosoboronexport, Moscow. The TEL vehicle was designed by Titan OKB in Volgograd, and manufactured by the Barrikady Industrial Association at Volgograd. The solid-propellant motor was manufactured by Soyuz NPO at Dzerzhisky.

SS-23 'Spider' (OTR-23/9M 714 Oka)

Type

Short-range, road-mobile, solid-propellant, single-warhead ballistic missile.

Development

The Russian designation for the SS-23 missile was OTR-23 (9M 714) and it was called Oka. The complete SS-23 system had the Russian designator 9K714. The missile was designed by the Kolomna OKB (also known as KBM), led by Sergei Nepobedimy, the same design bureau that developed the SS-21 'Scarab'. Acknowledged as an excellent design, the SS-23 was developed as a longer range version of the SS-21, to replace the SS-1 'Scud B'. The SS-23 began to enter service in 1980, but the missiles were withdrawn from service following the 1987 INF Treaty.

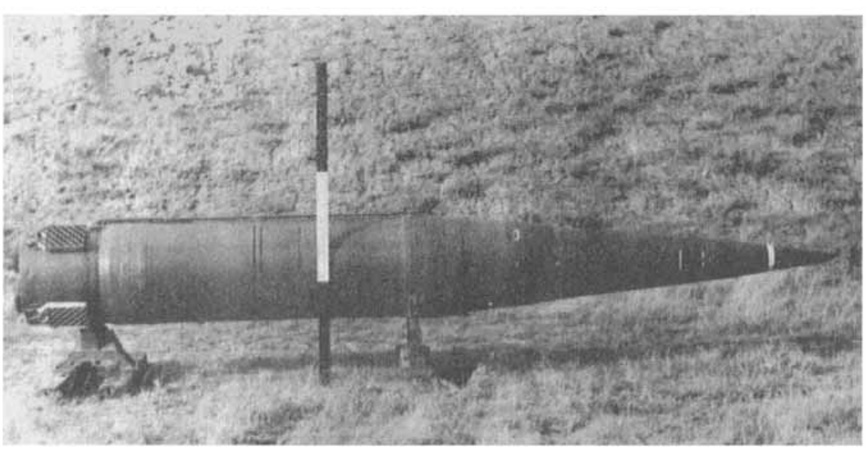
In 1995, the Russians announced the development of SS-X-26, a replacement for the SS-23 'Spider', but this time with a maximum range below the INF Treaty limits. It seems likely that SS-X-26 benefits from the technologies developed for the SS-23.

The SS-23 Spider' Transporter-Erector-launcher(TEL) vehicle (Stephen Zaloya) 0038260

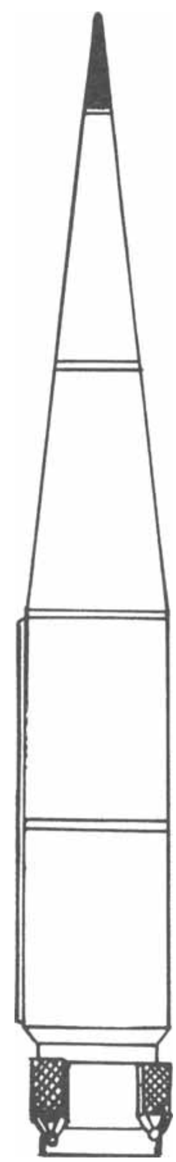
Description

The SS-23 'Spider' has a length of 7.32 m and a diameter of 0.97 m. Analysis of the photographs, however, indicates the diameter relates to the maximum dimension, and that the actual body diameter is 0.89 m. The launch weight of the missile is 4,630 kg. The propulsion system uses a single-stage solid propellant motor with four exhaust nozzles. The guidance system has a TsNIIAG inertial platform with an onboard digital computer, together with an active MMW radar comparison terminal homing system. This gives the missile an accuracy of 30 m CEP. Reaction time is estimated as 5 to 10 minutes. The missile can be equipped with conventional HE fragmentation (9M74F), HE submunitions (9M74K), chemical or nuclear (9M63) warheads. The missile had the designator 9M714B when fitted with a nuclear warhead, and the nuclear warhead had a weight of 772 kg. When fitted with an HE submunitions warhead, with 95 submunitions and a weight of 716 kg, the missile has the designator 9M714K. The INF Treaty declarations also included photographs of an earth penetrator warhead, which could have had either a nuclear or conventional HE explosive fitted. The missile has a minimum range of 50 km and a maximum range just over 500 km, although some reports suggested the maximum was 480 km. The INF Treaty of 1987 specifically included the SS-23 'Spider', indicating a range in excess of 500 km.

The 9P71 mobile Transporter-Erector-Launcher (TEL) vehicle is a four-axle vehicle, probably adapted from the former SS-12 'Scaleboard' TEL and using a BAZ-6944 chassis. Before a missile launch, the TEL is stabilised by four hydraulic jacks. The vehicle has an armoured enclosure wrapping around the missile when the SS-23 is in the horizontal travelling position; for protection against attack but also to provide a controlled temperature. It is reported that the vehicle has an inertial navigation system fitted, and does not need to go to pre-surveyed launch sites. The TEL is 11.76 m long, 3.13 m wide and has a loaded weight of 24,070 kg. It is believed that the TEL has a road speed of 60 km/h, can swim and is fully NBC



The complete SS-23 missile. a photograph provided with the INF Treaty data in 1987, and believed to be showing an earth penetrator warhead



Line diagram of the SS-23 missile 0038261

protected. A reload vehicle was provided, similar to the TEL, with the designator 9T230.

Operational status

The SS-23 entered service in 1980 and was located at sites in Bulgaria, Czechoslovakia, Germany and Russia. In November 1987, the Russians declared 127 missiles and 64 launcher vehicles operational, with a further 112 missiles and 42 launcher vehicles non-deployed. Under the terms of the 1987 INF Treaty, the Russian missiles were withdrawn and destroyed by May 1991. A total of 211 missiles were launched in tests and for training. A further 66 SS-23s were reported to have been exported to Bulgaria, Czechoslovakia and Germany around 1984. It was unclear what had happened to all these missiles, as they were not included in the INF Treaty destruction programme. It is reported that the Russians removed any nuclear warheads from these missiles in 1991. Germany received eight TEL and 24 missiles, and these have been destroyed. The Czech Republic retained two TEL and 12 missiles, but these have also been destroyed. Slovakia retained in service two TEL and six missiles, and these missiles were destroyed in 2000. Bulgaria has retained in service eight TEL and 24 missiles. An agreement was signed in May 2002 for these missiles to be destroyed by November 2002, but this had to be ratified.

Disassembled SS-23 'Spider' missiles. showing what appear to be active radar slot antennas on the nosecone sections

A derivative of SS-23 was proposed for use as a satellite launch vehicle in 1993, known as Sphera. This SLV had a launch weight of 3,300 kg and could have placed a 415 kg payload into a low Earth orbit at 275 km altitude. There have been no reported launches of the Sphera SLV.

Specifications

Length: 7.32 m
Body diameter: 0.97 m
Launch weight: 4,630 kg
Payload: Single warhead; 716 to 772 kg
Warheads: HE fragmentation, submunitions, chemical or nuclear
Guidance: Inertial plus active radar
Propulsion: Single stage solid
Range: 500 km
Accuracy: 30 m CEP

Contractors

The SS-23 missile system was designed by the Kolomna OKB (KBM) and built at the Votkinsk Machine Building Plant, Udmurt. The launcher vehicle was built at the VI Lenin Machine Building Plant, Petropavlovsk.

SS-24 'Scalpel' (RS-22/RT-23U)

Type

Inter-continental-range, rail-mobile and silo-based, solid-propellant, Multiple Independently targetable Re-entry Vehicle (MIRV)-capable ballistic missile.

Development

The SS-24 has the Russian designation RS-22 or RT-23U Molodets and the identification numbers 15Zh 60 and 15Zh 61 (for RS-22A or Mod 1 silo-based and RS-22B or Mod 2 rail-based versions respectively). The USA assigned generations to Soviet missiles and has designated the SS-24 as the first of the fifth generation, presumably because it was radically different from the SS-17, SS-18 and SS-19 group.

Development of the SS-24 began in 1971 and the first flight test was reported to have taken place in October 1982 from the Plesetsk test range. Thereafter, testing continued at a rapid pace, although there were believed to be several failures, with a successful launch, the 1lth, of a vehicle carrying eight Re-entry Vehicles (RVs) in November 1983. The first test launch of a rail-launched SS-24 was made in 1985, with the first silo launch made in 1986. The rail mobile SS-24 Mod 2 (RS-22B) version was deployed in 1987, with the silo-based SS-24 Mod 1 (RS-22A) version following in 1989 and displacing the SS-17 missile.

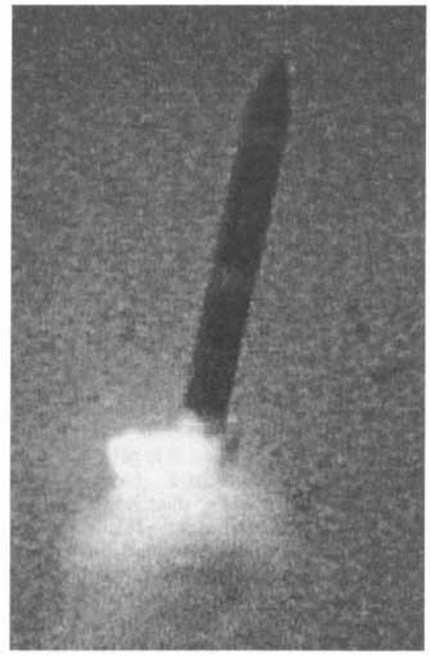
Line diagram of the SS-24 missile

NEW/0116330

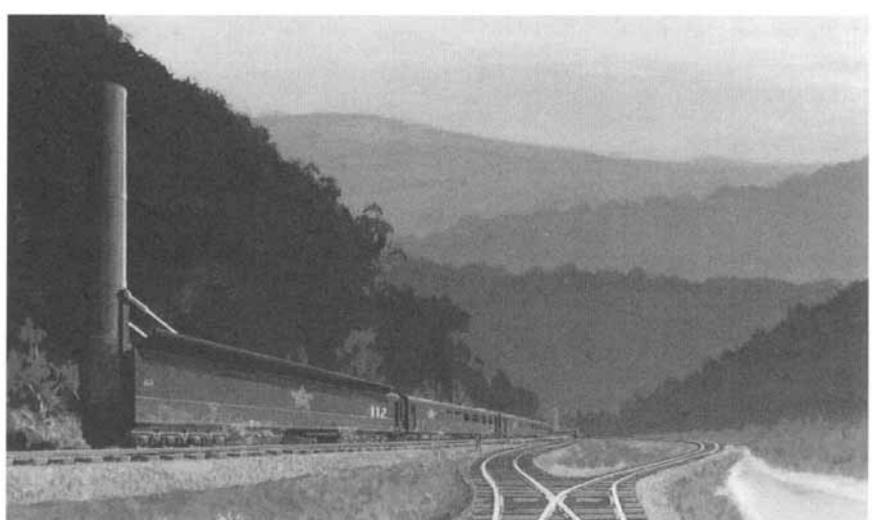
Description

The SS-24 falls into the Strategic Arms Limitations Treaty 2 (SALT 2) 'light' category of Inter-Continental-range Ballistic Missiles (ICBMs), a category including the liquid-propelled SS-19 and the US MX (LGM-118 Peacekeeper) missiles.

The SS-24 is a three-stage, cold-launched, solid propellant missile 22.4 m long for the Mod 1 silo-launched missile and 22.3 m long for the rail-launched Mod 2 version, and with a diameter of 2.4 m for each stage. Launch weight is 104,500 kg. It has a MIRV capability with 10 RVs, and these are fitted inside the nosecone assembly in a single ring. Decoys are also carried on the RV bus. The nose tip folds down inside the launch canister, and is erected during the launch sequence. The nosecone assembly is ejected when the missile reaches an altitude of 100 km during the ascent phase. In 1991, the Russians declared the SS-24 had a throw weight of 4,050 kg and carried 10 RVs. Subsequent information indicates that the payload bay is 2 m long, and that each RV carries a 550 kT nuclear warhead. There are only minor differences between the Mod 1 and 2 missiles, with the Mod 2 rail-launched missile having a larger cold launch assembly in a boat tail fairing, additional hot gas control for the first stage motor and a modified guidance and control system interface. The first stage has a weight of 53,700 kg, a thrust of 210 tonnes and is controlled by a pivoted motor nozzle. The second stage has a thrust of 107 tonnes and the third stage 21 tonnes. Both these stages are controlled by four small control fins on the nose cone section. The three solid-propellant motor stages are contained within composite cases. The bus vehicle uses liquid propellants, believed to be UDMH and nitrogen tetroxide. Guidance is inertial with a digital guidance and control system, believed to be an upgraded version of the system installed in the SS-18 'Satan' missile. The minimum range is expected to be around 2,500 km, and the maximum range is 10,000 km. The accuracy is 500 m CEP. It is reported that the SS-24 missiles have a design life of 11 years. The SS-24 launch canister is 22.6 m long, has a diameter of 2.7 m. The missile is cold launched by a solid-propellant gas generator contained within a 2 m high assembly ring that is jettisoned after launch at around 50 m altitude. Both rail and silo SS-24 versions are cold launched from their canisters. The launch silo complex has the Russian designator 15P961. The rail launch vehicle weighs 54,000 kg empty, is 23.6 m long and has a



This photograph. taken at Pans in 7995, is believed to show the test launch of an SS-24 missile (Duncan Lennox)



Artists concept of an SS-24 'Scalpel' missile, erected for launch on a train launch car

height of 5 m and a width of 3.2 m. The rail-cars have two four-axle bogies, a hinged roof, and can travel at up to 120 km/h. A standard train set has three diesel locomotives, three launchers, a command post and up to five rail-cars for support equipment and personnel. Each missile regiment has four train sets.

The mobile versions of the SS-24 may be seen as the parallel developments to the US work during the 1970s. to give their missiles survivability through mobility; the early US experiments included air, sea and ground launches of the Minuteman missile. All mobile systems suffer some degradation in accuracy, largely by disturbances to their guidance systems, and perhaps that led to the decision for dual-basing of the SS-24.

Operational status

The rail mobile version of the SS-24 Mod 2 was deployed in 1987, with the silo-based SS-24 Mod 1 deployment following in 1989 at converted SS-17 bases. In 1991, there were 56 silo-based missiles and 33 rail mobile missiles. The silos were at Tatischevo (10 silos) in Russia and at Pervomaysk in Ukraine (46). There were three rail garrisons in Russia at Bershet (9). Kostromo (12 launchers), and Krasnoyarsk (12). Training facilities were at Perm and Plesetsk, with storage at Khrizolitovily with six missiles. There are eight test silos at Plesetsk. The Russians announced in August 1990 that SS-24 missile production would cease in 1991 and only three more missiles were built. As the missiles were designed and built in the Ukraine, Russia has been dependant upon Ukrainian support for post-design services and spares.

In 1991, the Yuzhnoye NPO proposed using the SS-24 missile as a civilian satellite launch vehicle, including a scheme known as 'Space Clipper', which would involve an SS-24 being carried to 10,000 m (33,000 ft) altitude in a converted Antonov An-124 aircraft, rolled out by parachute and then launched from a vertical position. In 1994, proposals were made to launch satellites using a converted SS-24 missile launched from a floating barge in the Black Sea.

Following the Strategic Arms Reduction Treaty 2 (START 2) agreements and ratification by Russia in May 2000, the SS-24 'Scalpel' missiles are expected to be phased out and destroyed by 2007. Although START 2 has been abandoned, it is still expected that the SS-24 missiles will be taken out of service. In 1994, Ukraine started to deactivate the 46 missiles at Pervomaysk by removing warheads, and it is believed that all the Ukraine missiles were non-operational in December 1994. Ten missiles had been destroyed in Ukraine by September 1998, and the remainder were destroyed by December 2001, together with the silos and command posts. By mid-1995, it was reported that Russia had 10 'Scalpel' missiles in silos and 36 rail-mounted missiles in service, and by July 2002 all the silo-based missiles had been destroyed and the silos at Tatischevo converted for SS-27 missiles. A further 12 missiles were in storage in 1995, four Mod 1 and eight Mod 2 versions. A test launch of an SS-24 Mod 1 rail-launched missile was made from the Plesetsk test site in December 1996, and a further test was reported in December 1998.

Specifications

Length: 22.4 m (Mod 1), 22.3 m (Mod 2)
Body diameter: 2.4 m
Launch weight: 104,500 kg
Payload: 10 RVs in MIRV configuration
Warhead: 550 kT nuclear each
Guidance: Computer-controlled inertial through flight, including PBV
Propulsion: 3-stage solid plus PBV
Range: 10,000 km
Accuracy: 500 m CEP

Contractors

The SS-24 was designed by the Yangel/Utkin Design Bureau (OKB-586); some missiles were manufactured by the Yuzhnoye NPO, Dnepropetrovsk, Ukraine, and some at Pavlograd, Ukraine.

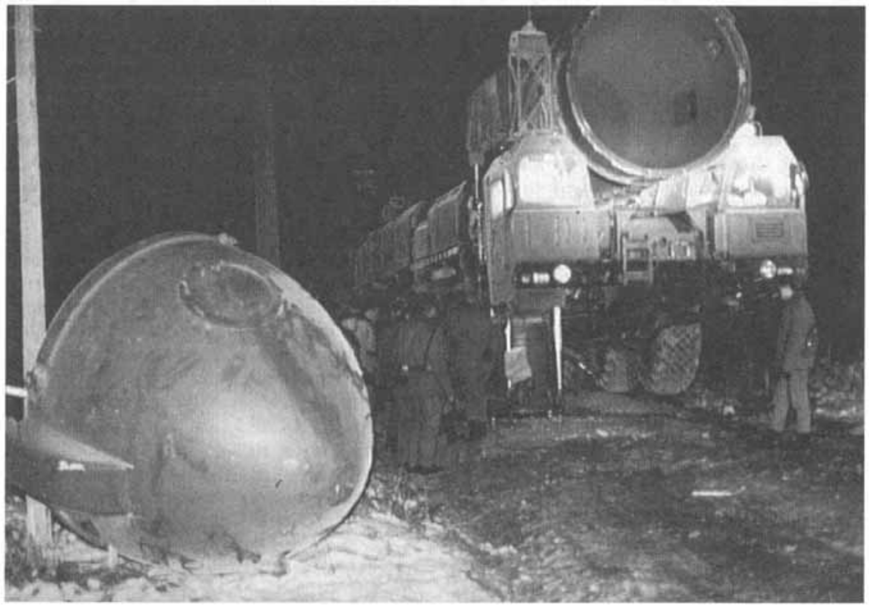
SS-25 'Sickle' (RS-12M/RT-2PM/Topol)

Type

Inter-continental-range, road-mobile, solid-propellant, single-warhead ballistic missile.

Development

The SS-25 has the Russian designation RS-12M, is called 'Topol' (poplar tree), and has the identification number 15 Zh 58 or RT-2PM. Design of the SS-25 began in 1971 with test flights commencing in 1982, successful tests being achieved over long range by mid-1983. The SS-25 has a single warhead and as such can be seen as the logical successor to the liquid propellant SS-11 and the solid propellant SS-13. The Soviets claimed the missile was a direct modernisation of the SS-13 and thus within the requirements of the Strategic Arms Limitations Treaty 2 (SALT 2) covering modernisation. The SS-25 'Sickle' design used several systems developed earlier by the Nadiradze Design Bureau for its SS-20 'Saber' mobile ballistic missile system. Originally, the USA expected Russia to develop a multiple warhead version of the SS-25 'Sickle' following a four Re-entry Vehicle (RV) flight test in May 1983. However, the Strategic Arms Reduction Treaty 1 (START 1) declaration in 1991 clarified the issue, confirming that only single warhead versions were in service. As the SS-25 had been largely manufactured in Ukraine, the Russians developed the SS-27 from assemblies manufactured in Russia. The first trial launch of the SS-27 missile, named Topol-M in Russia, was carried out in December 1994 (see separate entry).



An SS-25 'Sickle' TEL vehicle just after a training missile launch from a deployed site. The vehicle is still on its stabilising jacks, and the nosecone for the launch canister is at the left of the picture
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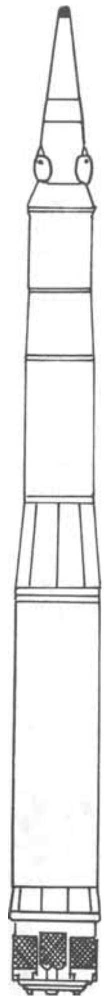
Description

The SS-25 is a cold-launched, three-stage, solid propellant, road-mobile ballistic missile. It is 20.5 m long, with the first-stage diameter 1.8 m, the second-stage diameter 1.55 m and the third-stage 1.34 m. The three solid propellant stages are made from composites. Guidance is inertial, with a digital guidance and control system. Its launch weight is 45,100 kg, with range capability of 10,500 km. It has a single RV, with a nuclear warhead having a yield of 550 kT, and the Russians declared a throw weight of 1,000 kg in 1991. It is believed that the payload includes decoys. The missile has eight lattice paddle-type fins at its base, four to provide stability of the missile and four to control the missile during the launch phase. In addition, first stage control is augmented by jet vanes in the motor nozzle. The second and third stages are controlled by eight roll and yaw motor nozzles fitted at the top of the third stage, with gas injection into the second- and third-stage motor nozzles. It is believed that the design life of the missile was initially 20 years, but that a proposal was made in 2000 to extend this life by 5 to 10 years.

The Transporter-Erector-Launchers (TELs) operate out of bases to presurveyed launch sites usually in forest areas, but the Krona TEL storage sites have sliding roof garages, from which the missile can be launched in an emergency. The SS-25 TEL is similar to the MAZ-547 used with the SS-20 system, but has an additional seventh axle and has the Russian designator MAZ-7912 or 7916 for the 14 × 14 wheeled vehicle. Each axle on this new TEL is steered independently. The TEL

Two SS-25 Sickle Transporter-Erector-Launcher (TEL) vehicles at the Moscow Parade in September 1990 (TASS)



A line diagram of the SS-25 'Sickle' missile

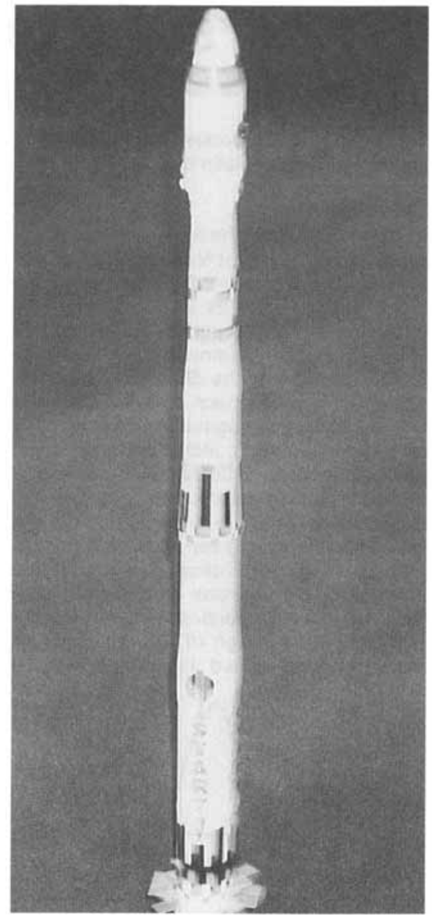
has a length of 17.3 m, a width of 3.0 m and a height of 3.1 m. The missile is stored and fired from a launch canister that is 22 m long and 2 m in diameter; the nose section is removed shortly before the missile is launched. The missile is cold-launched from the canister, using a solid propellant gas generator. The complete TEL vehicle is raised on four hydraulic jacks for stability at missile launch. The TEL has command and control, navigation, target selection and power supplies contained within the vehicle. Each battery also has a separate four axle truck for use as a command post.

Operational status

The SS-25 'Sickle' entered service in 1988, and in 1991 there were 288 missiles deployed at nine sites. There were two sites in Belarus, at Lida (27 TELs) and Mozyr (27); and seven sites in Russia, at Teykovo (36 TELs), Yoshkar-Ola (18). Yuryu (45). Nizhny-Tagil (45). Novosibirsk (27), Kansk (27) and Irkutsk (36). Training facilities were located at Serpukhov, Perm, Plesetsk, Balabanovo and Goryachiy Klyuch. Missile storage for SS-25 was at Surovatikha and Khrizolitovy with 48 missiles. Testing is carried out at Plesetsk with five TELs located there. There were 17 further SS-25 TELs non-deployed in July 1991. The production rate in 1990 was reported to be 56 missiles per year. From 1992, there was a reduced production rate, and it is believed that 20 were built in 1993 and nine in 1994. It is believed that around 450 missiles were built and that production ceased in 1994.

Following the START 2 agreements it is expected that SS-25 missiles will be restricted to their garrison areas, and that some might be relocated into converted SS-18 silos in Russia. Proposals were made in 1992 to develop a commercial satellite launcher based upon the SS-25 'Sickle' design, offering mobile launch facilities around the world to place 500 kg payloads into low Earth orbits. A trial launch of a converted SS-25, known as Start 1, was carried out in March 1993 and is believed to have used an additional fourth orbital injection stage giving the launch vehicle an overall length of 27 m. The first operational launch of the Start 1 vehicle, in March 1995, resulted in failure at the final fourth stage, and the loss of the three satellites onboard. A second successful launch was made from the Svobodny Cosmodrome in March 1996. A five-stage Start 2 satellite launch vehicle, with an increased length of 29 m and a launch weight of 60,000 kg, is in development. Start 2 will be able to launch payloads of up to 750 kg into low Earth orbit, and the first launch is now planned to be made from the Woomera test range in Australia in 2003.

In July 2002, it was believed that there was a total of 355 SS-25 'Sickle' missiles operational. The last missiles from Belarus were returned to Russia in November 1996. A further number of missiles were in storage, together with some TEL vehicles, but the numbers are not known. Test launches of SS-25 were made in November 1995, April 1996, November 1996, September 1998, October 2000, February 2001, July 2001, October 2001 and December 2001. The July 2001 test was unusual in that the RV flew several hundred kilometres at around 33 km altitude, which would suggest either that this RV had wings and a motor fitted, or that it was being used as a trials vehicle for a hypersonic missile test. A silo-launched version of SS-25 was tested in July 1996. It is reported that a total of 77 SS-25 'Sickle' missiles had been launched by June 2001.



This picture shows a model of the Start 1 satellite launch vehicle. displayed at Paris in 1995. The first three stages of the SLV are derived from the SS-25 'Sickle' ballistic missile and indicate the probable missile shape. The eight extended stabiliser/ control fins can be seen at the base of the model (Duncan Lennox)

Specifications

Length: 20.5 m
Body diameter: 1st-stage 1.8 m; 2nd-stage 1.55 m; 3rd-stage 1.34 m
Launch weight: 45.1 00 kg
Payload: Single RV on a PBV
Warhead: 550 kT nuclear
Guidance: Computer-controlled inertial
Propulsion: 3-stage solid plus PBV
Range: 10,500 km
Accuracy: 200 m CEP

Contractors

The SS-25 missile was designed by the Nadiradze Design Bureau and produced at the Votkinsk Machine Building Plant, Udmurt. The TEL was manufactured at the Barrikady Industrial Association at Volgograd and the solid propellant motors were made at the Soyuz NPO, Dzerzhisky.

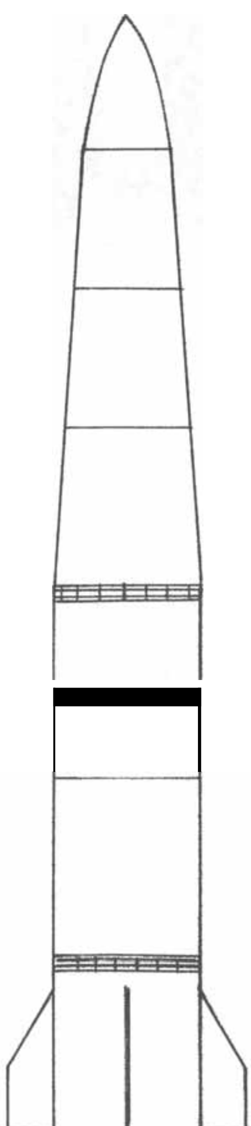
SS-X-26 'Stone' (9M72 Tender/Iskander-E)

Type

Short-range, road-mobile, solid-propellant, single-warhead ballistic missile.

Development

In the early 1970s. the former Soviet Army sought a replacement for the SS-1 'Scud B' system. The two main problems with the 'Scud' system were its slow reaction time (around 90 minutes) and its poor accuracy when using conventional warheads (for further details on the SS-1 see separate entry). The requirement was for a missile that could be used against both stationary and moving targets, including SAM sites, SRBM launchers, airfields, ports, command and communications centres, factories and hardened targets. SS-X-26 'Stone' is the NATO designation given to a new missile first tested by the Russians in late 1995. There are two versions of this missile; a Russian service version called Tender (9M72) with a range of 400 km, and an export version called Iskander-E with a range of 280 km. From information released the SS-X-26, nicknamed 'son of Scud', is the second attempt to replace the 'Scud' system, since the first attempt, the SS-23 'Spider', was eliminated under the Intermediate-range Nuclear Forces (INF) Treaty between the USA and USSR in 1987 (see separate entry). The Russian Army were most concerned about the elimination of the 500 km range SS-23 missiles, as this left the much shorter range SS-21 'Scarab' as the only tactical short range ballistic missile available.



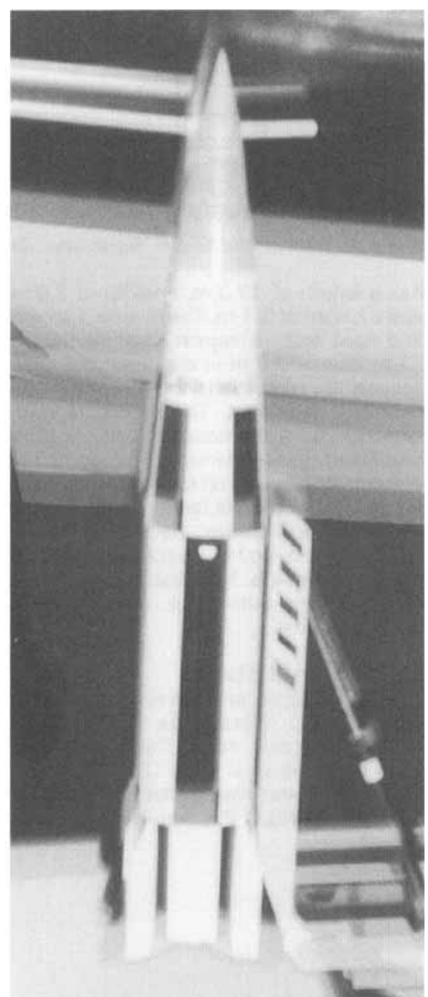
A line diagram of the SS-X-26 missile
NEW/0145010

In 1991, following the collapse of the Soviet Union, the Machine Industry Design Bureau (KB Machinostroyenia) in Kolomna (previously OKB-52). which had been responsible for the design of the SS-21 'Scarab' and SS-23 'Spider', attempted to stay in business by conversion projects, and began efforts to export civilian space launchers. Using the solid propellant motor from the SS-23 'Spider', KB Machinostroyenia developed a satellite launch vehicle named Sphere (Sfera) that was offered to international customers at a number of aerospace exhibitions, including the 1994 Farnborough and 1995 Paris air shows. The Sphere space launcher is also known in the West as the KY-19, a designation applied after test launches of the vehicle were observed taking place from the Kapustin Yar proving ground. These tests are believed to have assisted in the development of the SS-X-26, which is thought to use a derivative of the Sphere's motor. Although the SS-X-26 is a direct evolution of the SS-23 and the Sphere space booster, it is believed that many improvements have been made to the new design. One of the outstanding questions about the programme is the system's range and payload. The maximum range is stated to be 400 km for the Russian service version, which is below the 500 km range limit set by the INF Treaty, and the Russians have stated that the missile is within those guidelines. However, the Russians plan to export the SS-X-26, and the range/payload limits laid down by the Missile Technology Control Regime (MTCR) are 300 km range and 500 kg payload. The Iskander-E export version of the missile has a maximum range of 280 km, and a payload of 480 kg.

The initial Transporter-Erector-Launcher (TEL) used to transport and launch the SS-X-26 was based upon the BAZ-5921 design used with the SS-21 'Scarab' system, and carried a single missile. The present TEL is based on the 9P71 vehicle used in the SS-23 system, and this vehicle carries two missiles. However, the new TEL has been designed with the INF Treaty in mind, with several changes that clearly differentiate the two vehicles to prevent any difficulties over treaty compliance.

Description

The SS-X-26 is a short-range, road-mobile, single-stage, solid propellant single-warhead missile based on the SS-23 'Spider' and similar in appearance to the Sphere satellite launch vehicle. The Tender missile is 7.3 m long, has a body diameter of 0.92 m and a launch weight of between 3,800 and 4,020 kg, depending on the payload. Propulsion is by a Soyuz NPO single-stage solid-propellant motor, with control provided by a TVC system as well as four moving tail fins. The tail fins can move up to 30° at 130°/s. The guidance system uses a TsNIIAG-developed inertial/GPS unit, with Glonass position system updates during mid-course. Terminal guidance is believed to be provided with either an active radar or optical (TV or imaging IR) scene matching system. It is believed that the SS-X-26 missile uses a Central Scientific Research Institute for Automation and Hydraulics (TsNIIAG) scene matching or area correlation system, and that one of the three sensor types can be selected depending upon the target environment. The payload section, with the warhead and terminal guidance system. separates from the motor assembly during flight, and is guided by four thrust and divert motors. It is reported that the missile can make evasive manoeuvres up to 30 g during the terminal phase, to prevent interception by a surface-to-air missile. The missile has been credited with an accuracy of 10 to 30 m CEP. The SS-X-26 has



A model of the Sphere satellite launch vehicle displayed at the Paris Air Show in 1995. The SS-X-26 is similar
(Duncan Lennox)

several conventional warhead options weighing between 480 and 700 kg depending on type. These are believed to include 54 anti-personnel/anti-material blast/fragmentation HE submunitions, area denial submunitions, HE unitary, fuel-air explosive, tactical HE earth penetrator for bunker busting, an EMP, and an anti-radar blast/fragmentation warhead. It is also possible that the payload could include tactical decoys. The minimum range is estimated to be around 100 km, and the maximum range 400 km. The maximum range will be reduced as the payload weight increases, and it is expected that with the maximum 700 kg payload the missile has a maximum range reduced to 300 km. It is reported that the missile can remain below 50 km altitude, similar to the flight path available to the ss-21.

The export version of the missile, called Iskander-E, is similar to the Russian service version (Tender), but with a reduced payload and reduced maximum range. The missile weight at launch is 3,800 kg. This version has a 480 kg payload, that can be 54 anti-personnel/anti-material blast/ fragmentation submunitions, area denial submunitions, HE unitary or an HE penetrator. The minimum range is 50 km, and the maximum range 280 km. This version has an optical correlation terminal seeker, with digital target area data taken from satellite or aircraft photographs and images. The ground launch operator in the Target Designation Vehicle (TDV) sets an electronic marker on his display screen over the target, and this information is then passed to the missile before launch. The accuracy will depend on the terminal guidance system selected when the missiles were ordered, but could be 200 m CEP with inertial guidance, 50 m CEP with inertial and GPS/Glonass updates, or between 10 and 30 m CEP with inertial, GPS/Glonass and optical correlation.

The transporter-erector-launcher vehicle (9P78) is similar in appearance to the 9P71 TEL used by the SS-23 'Spider', and has four axles, but carries two missiles. Developed by the Titan Central Design Bureau in Volgograd and based on a MZKT 7930 chassis, the TEL has two armour-plated sliding roof sections to protect the missiles, which also provide a climate-controlled interior to the TEL. The missiles can withstand outside temperatures between ±50°C. The TEL has a length of 13.1 m, a width of 2.6 m and a height of 3.55 m with the two missiles in the stowed travelling position. The fully loaded weight is 42,850 kg. This TEL has a 650 HP diesel engine, with a maximum road speed of 70 km/h, and an unrefueled range of 1,100 km. The vehicle has a launch crew of three, has full Nuclear, Biological and Chemical (NBC) protection and has amphibious capabilities. The TEL contains a command post with an automated fire control system, *so* that each TEL can operate independently if necessary. The command post has target data and designation. navigation and weather control positions, as well as built-in system test equipment. The TEL can be positioned on sloping ground, and leveled with four hydraulic jack supports within 30 to 80 seconds. The missiles are raised to an angle of 91.5°, which takes around 20 seconds. The reaction time can vary between 5 and 16 minutes, and two missiles can be fired in salvo with 60 seconds between launches. The TEL can be carried by an 11-76 'Candid' transport aircraft. There is also a transporter-loader vehicle (9T250), which carries two reload missiles and a crane. This has a crew of two, and a fully loaded weight of 40,000 kg. There are four other vehicles based on the six-axle KamAZ 43101 truck chassis. These are a command and control post with four operator stations and a communications suite, a target designation vehicle with two operator stations, a maintenance vehicle, and a crew accommodation vehicle. A typical operational battery is expected to consist of three TELs with three reload vehicles.

Operational status

The first full test flight of the SS-X-26 took place in October 1995, and further tests were reported in 1996. No details have been released regarding deployment of the system, but reports in 1996 suggested that the programme was close to initial production and could enter service in 1998 or 1999. By November 1998 it was clear that funding limitations had delayed the final test programme and production orders, and it was reported that low rate initial production might start in 1999 or 2000. However, by June 2002 there was still no confirmation that a production order had been placed by the Russian Army. The Iskander-E export version was displayed in November 1999, and it was reported that the first possible purchaser would be the UAE, although this has not been confirmed. In March 2001 it was reported that Iran might be negotiating a purchase, and that development and testing of the Iskander-E version would be complete by December 2001. It seems likely that an export order will be required to start production, and that the Russian service version (Tender) may not enter service until 2002 to 2005. It is believed that production of the missile will probably take place at Votkinsk, as was the case of the SS-23 'Spider'. Up until the break-up of the Soviet Union, most Russian missile TELs had been produced at a manufacturing plant in Kazakhstan. However, in keeping with the requirement of the Russian armed forces to ensure future weapons will be manufactured on Russian soil, the SS-X-26 TEL is to be manufactured by the Barrikady Plant in Volgograd.

Specifications

Length: 7.3 m
Body diameter: 0.92 m
Launch weight: 3,800 to 4,020 kg
Payload: Single warhead 480 to 700 kg
Warheads: HE unitary, HE submunitions, FAE, HE penetration
Guidance: Inertial plus Glonass with radar, TV or IIR scene matching
Propulsion: Solid propellant
Range: 280 km (Iskander-E) or 400 km (Tender)
Accuracy: 10 to 30 m CEP

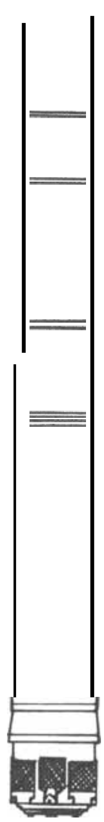
Contractors

The SS-X-26 is designed by the KB Mashinostroyenia, Kolomna, and manufactured at the Votkinsk Machine Building Plant, Udmurt and with the solid propellant motors built by Soyuz NPO at Dzerzhisky. The TEL vehicle has been designed by the Titan Central Design Bureau at Volgograd, and built by the Barrikady Plant at Volgograd.

SS-27 (TOPOL-M, RS-I2M1/-12M2)

used on the SS-25. Russian accounts have stressed the invulnerability of the new missile to anti-ballistic missile defences, and the missile has a more energetic first-stage engine and incorporates a new warhead and re-entry vehicle. A flight test in June 1999 confirmed that the re-entry vehicle can manoeuvre to avoid interception during the terminal phase, and it must be expected that the payload includes countermeasures. Russian reports suggest that previous Russian warheads could be rendered ineffective by nuclear blasts up to 10 km away, while the new system can withstand explosions closer than 500 m range. There have been unconfirmed reports that the new Topol-M would be capable of carrying up to six warheads, but the tests to date have been limited to a single nuclear warhead only.

A proposal was made in 1998 to develop a naval version of the SS-27 missile as an SLBM, to replace the SS-NX-28 missile, which had development problems. This proposal is believed to have been made jointly between MIT and the Makeyev design bureau. The SLBM variant is called 'Bulava', and may be fitted to the 'Borey'class SSBN, the first of this class is expected to be commissioned in 2006. It is reported that a design requirement for the SS-27 missile was that the first three stages could be used as a satellite launch vehicle, but there are no known test launches.



A line diagram *of* ***the*** *SS-27 (Topol-M)* missile

Description

The SS-27 Topol-M is a cold-launched, three-stage, solid-propellant, silo-based or road-mobile ballistic missile that has an overall length of 21.9 m. The first stage is believed to be 10.5 m long and has a body diameter of 1.9 m. At its base, similar to the earlier SS-25 'Sickle', it employs Belotserkovskiy control surfaces. There are eight of these waffle-patterned folding fins, four are for stability, while the four others have movable louvres for control purposes during the boost phase of the missile's flight. However, an unconfirmed report suggests that these eight fins have been deleted on the latest modification missiles. Stage two is 5.2 m long and has a body diameter of 1.61 m. Stage three is around 3.1 m long (without re-entry vehicle/ warhead assembly) and has a body diameter of 1.58 m. The remainder of the missile's length is taken up by the long pointed cone-shaped nose-section that houses the re-entry vehicle. The missile has a launch weight of 47,200 kg. Guidance is by an onboard digital inertial navigation system with a Glonass receiver, providing an accuracy of 350 m CEP. There is a downlink from the missile to the ground station, so that the missile's position can be transmitted to launch control. The minimum range is believed to be 2,000 km, and the maximum range 10,500 km. The missile has a life of between 15 and 20 years.

It is believed that the SS-27 missile carries a single nuclear warhead with a 550 kT yield, although one Russian report suggests a yield of 1 MT, with countermeasures, and has a throw weight of 1,000 kg. It is believed that the missile is stored and cold launched from a launch canister similar to that used with the SS-25, but that the SS-27 canister has a flatter nose shape. When silo-based, it is deployed from modified SS-18 'Satan', SS-19 'Stiletto' or 'SS-24 'Scalpel' silos. When used in the road-mobile configuration it uses a modified eight-axle SS-25 Transporter-Erector-Launcher (TEL) with 16 × 16 wheeled drive, believed to have the designator MAZ-7916. The TEL has a length of 22.8 m, a width of 3.05 m, and a height of 3.8 m. The TEL was developed by the Titan Central Design Bureau at Volgograd, and built at the Barrikady Plant in Volgograd.

Operational status

The first launch of SS-27 Topol-M took place in December 1994, with eight more tests between September 1995 and December 1999. Further tests were made in February 2000, and two in September 2000. The second test in September 2000 was the first launch from a TEL vehicle, and it is believed that a further ten TEL launches are planned up to 2005. Two missiles entered service with the Taman Missile Division in December 1997 in modernised SS-19 missile silos at Tatischevo. In 1998, it was reported that Russia planned to build around 350 SS-27 missiles, with probably 270 in silos and 80 road-mobile. However, by July 2002, this plan had been modified, and it is expected that around 50 missiles will be built by 2005. Around 33 former SS-19 and 10 former SS-24 silos at Tatischevo are planned for conversion to take the SS-27 missiles. The first regiment of 10 missiles was operational at Tatischevo by the end of 1998. with a second regiment of 10 missiles operational by December 1999. A third regiment was declared operational in December 2000, but with onlyfour missiles, and a further six missiles were delivered in 2001. The 30 operational missiles were all in silos at Tatischevo, and it is believed that 12 silos are provided for each regiment of 10 missiles. The first TEL missiles are reported to have entered service in 2001, and are believed to be based at Tatischevo for the present time. Although the production rate was planned to increase from 10 per year in 1999 to 30 missiles per year from 2001 onwards, the actual rate has been just 6 missiles per year for 2001 and 2002. A report in 1998 suggested that the mobile launchers would be based at Valdaif and Altaif, using a former SS-17 launch complex.

Specifications

Length: 21.9 m
Body diameter: 1st stage 1.9 m; 2nd stage 1.61 m; 3rd stage 1.58 m
Launch weight: 47,200 kg
Payload: Single RV on a PBV
Warhead: 550 kT nuclear
Guidance: Inertial with Glonass
Propulsion: 3-stage solid plus PBV
Range: 10,500 km
Accuracy: 350 m CEP

Contractors

The Topol-M was designed by the Moscow Institute for Therrnotechnology (MIT) and assembled at the Votkinsk Machine Building Plant, Kolomna. Solid propellant motors are made by Soyuz NPO, Dzerzhisky, inertial guidance and control system by the Automatic Equipment and Instrument Production NPO, Moscow and the nuclear warhead by Arazmus-16 (VNIIEF) at Nizhniy Novgorod. The TEL was designed by the Titan Central Design Bureau at Volgograd, and manufactured by the Barrikady Plant at Volgograd.

SS-N-2/SSC-3 'Styx' (P-15/27 Termit and 4K40/4K51)

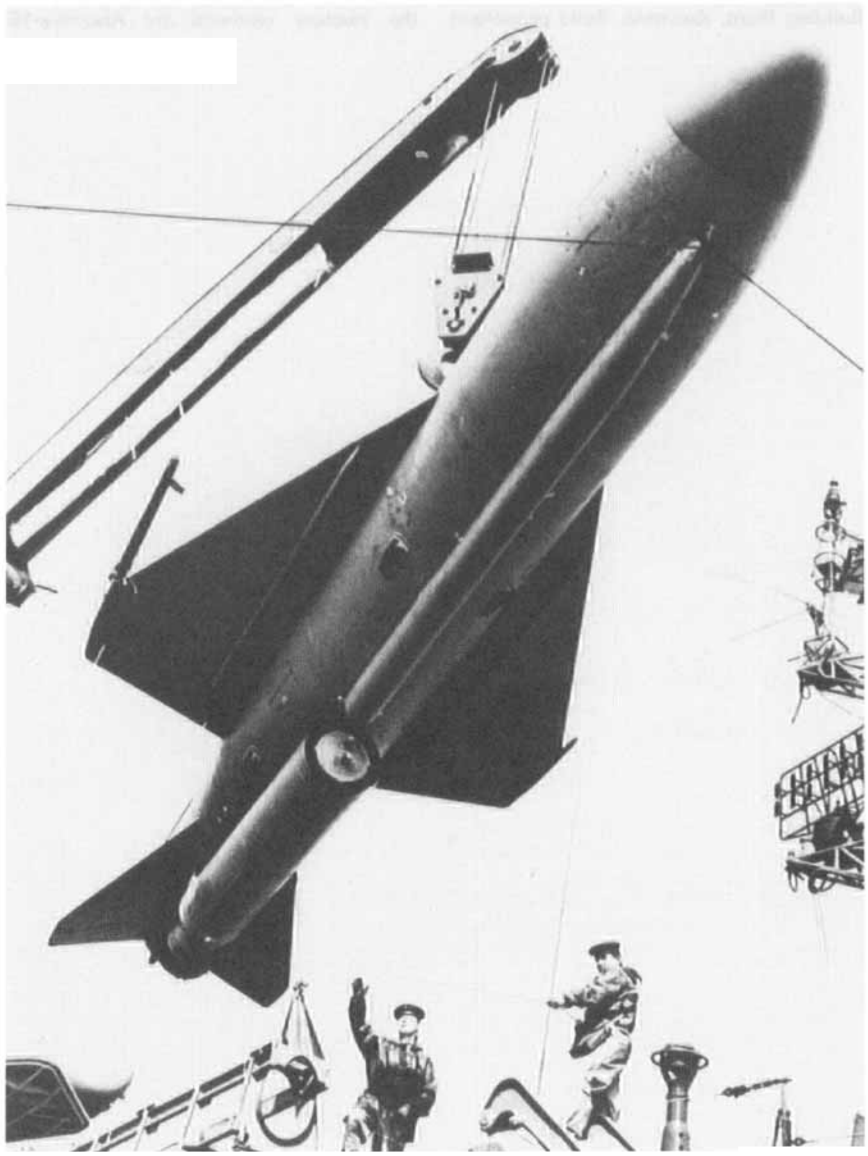
Type

Short-range, ship- and ground-launched, liquid fuel-propelled, single-warhead, surface-to-surface missiles.

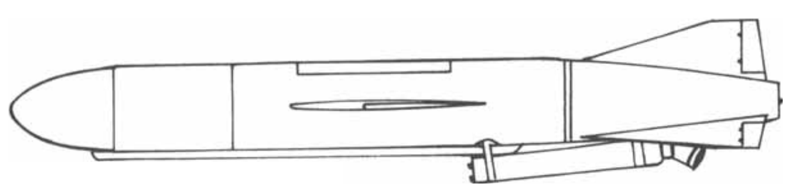
Development

The development of the SS-N-2 'Styx' family of anti-ship weapons began in the mid-1950s and the first missiles entered service in 1960. The Russian designations are reported to be P-15 Termit (4K40) and P-27 (4K51) for the versions that have been reported, and identified by NATO as SS-N-2A, B, C, D and E models. The coastal defence version, named Rubezh by the Russians, has the NATO designator SSC-3. The SS-N-2A was first seen in operational service in 1960 on 'Osa 1' and 'Komar' class missile boats. The SS-N-2B model appeared in 1965 on updated versions of the same boats. The SS-N-2C has been seen fitted to several destroyers as well as arming the 'Osa 2' class missile boats, and it is believed that this version was misidentified by NATO as SS-N-11 when it first entered service in 1972. The SS-N-2D/E have been fitted to 'Tarantul 1/2' corvettes. The 'Styx' missile has the distinction of being the first of its type to have been used operationally, in the 1967 war between Egypt and Israel.

The SSC-3 land-based coastal defence version entered service in 1978 and this is similar to the 'Styx' missile in the folding-wing SS-N-2C version. The SS-N-2 'Styx' has been fitted to 'Modified Kashin' (Type 61M) destroyers in four single-launch canisters, frigates of the 'Koni' class with four missiles in twin launchers, missile corvettes of the 'Tarantul 1/2' and 'Nanuchka' class with four missiles in twin launchers, 'Osa 1/2' class fast attack craft-missile with four launchers and missile hydrofoils of the 'Matka' class with two canisters. SS-N-2 was exported to China where it was designated SY-1, then modified by the Chinese as HY-1 and HY-2, then further developed with a turbojet variant known as HY-4 (C-201) and ramjet variants known as YJ-16 (C-101) and HY-3 (C-301). The Chinese versions of 'Styx' were known generally as the 'Silkworm' missile, although in fact there were several different versions built and exported. 'Styx' were also exported to Iraq, where they have been developed as the FAW family, with ranges extended to 200 km. Either Russia or China exported 'Styx' or HY-1/ HY-2 missiles to North Korea, where they have also been manufactured and exported to other countries. Iran imported Chinese HY-1 and HY-2 missiles, and then built these missiles themselves, with production starting around 1987.



A Russian SS-N-2 'Styx' missile being lowered into the launch canister on a ship, showing the solid-propellant boost motor underneath the rear body



A line diagram of an SS-N-2C Styx' missile

Description

The general configuration of the SS-N-2 'Styx' family is that of a small aircraft, with a delta wing and a triple tail surface arrangement. There have been three distinct versions reported, identified as the SS-N-2A. B and C models respectively. The SS-N-2A (P-15 Termit) has a length of 5.2 m, a body diameter of 0.76 m, a wing span of 2.0 m, a warhead of 350 kg and a launch weight of 2,100 kg. Guidance in mid-course is by an AM-15A autopilot with a barometric altimeter, and the missile could be set to cruise at altitudes between 100 and 300 m. The missile has an MS-2 active radar terminal seeker, with six pre-selected frequencies and a range of 10 km. The liquid-propellant motor uses kerosene TG-02 and RFNA (4K-20K) pressurised by compressed air, and gives the missile a minimum range of 20 km and a maximum of 35 km. At launch the SPRD-30 solid-propellant boost motor, attached under the rear body of the missile, powers the missile out of its canister and into a climb, and is then jettisoned. Target acquisition for the SS-N-2A missile system was by either a Rangout surveillance radar, with the NATO designator 'Square Tie', or by a PMK-453 optical sighting system. The initial 'Komar' class fast attack craft only carried two missiles, but the 'Osa 1' boats carried four missiles.

The SS-N9B (P-15U) is similar to the earlier version but with folding wings, longer range, radio altimeter and smaller

launch canisters. An alternative 'Snegir' Infra-Red (IR) terminal seeker was developed for this missile. The missile is 5.8 m long, has a diameter of 0.76 m, a wing span (unfolded) of 2.41 m, and a launch weight of 2.300 kg. This version cruises at a height between 100 and 200 m. A larger 450 kg HE warhead is fitted, and increased fuel/oxidant increases the maximum range to 40 km. The minimum range is reduced to 8 km. An improved fire-control system, Klen 205, is fitted in the boats, together with a smaller cylindrical canister KT-97 launcher.

The SS-N-2C (P-15M) has folding wings with an unfolded span of 2.5 m, is 6.5 m long, with a body diameter of 0.78 m and a weight of 2,500 kg at launch. It has a larger warhead of 513 kg and an increased maximum range of 80 km. The minimum range is 8 km. This version introduced new liquid oxidant and propellants, using amine and UDMH to reduce the risks of fire and corrosion from the earlier nitric acid systems, and with a thrust of 1.2 tonnes. The terminal phase is flown at 2 to 3 m altitude, and an upgraded terminal active radar seeker, known as MS-2A. is fitted with improved range, accuracy and ECCM capabilities. An unconfirmed report states that the SS-N-2C version has a cruise speed of M1.3, although most reports indicate a cruise speed of M0.8 to M0.9. Over the years several guidance modes have been employed: the mid-course phase could be carried out under either autopilot or radio-command guidance, and the terminal phase could rely upon continuation of command guidance, active radar, or infra-red homing. Some reports indicate that SS-N-2D has an infra-red terminal seeker. The 80 km maximum range capability of SS-N-2C 'Styx' can only be achieved with over-the-horizon targeting and command updates using Ka-25 'Hormone-B' or Ka-27 'Helix-B' helicopters. It is believed that SS-N-2E (P-27) is similar to the -2C version but with an improved active radar terminal seeker. The Russians usually gave different designators to export missiles and the various upgrades, but it is not clear which designators were used with the various 'Styx' missile systems.

The SSC-3 'Styx' coastal defence variant is an updated and modified version of the SS-N-2C (P-15M) missile. The SSC-3 outline is the same, and it has the same length of 6.5 m, body diameter of 0.78 m and launch weight of 2,500 kg. Guidance for the mid-course phase is by programmed autopilot, and an active I-band radar or passive infra-red seeker head provides the terminal guidance. The missile warhead weighs 513 kg and contains conventional High Explosive (HE). The flight altitude can be preset in a multiple of five steps between 50 and 300 m with the terminal trajectory being effectively a shallow dive. The Transporter-Erector-Launcher (TEL) vehicle is based upon the SS-1 'Scud B' MA2-543 TEL, with a Garpun surveillance radar (NATO name 'Plank Shave') elevated on the forward section of the vehicle and two missiles in KT-161 canisters on launch ramps beside each other at the rear of the vehicle. When launched from the TEL, elevated to its maximum height and under its own 'Plank Shave' radar, the effective range is only 35 km. However, this can be extended to about 80 km by means of a forward command link provided by a co-operating aircraft, helicopter or ship. There are unconfirmed reports that some missiles may have been modified with smaller warheads and increased fuel, to extend the maximum range out to 105 km. The 3S51 TEL has a length of 13.95 m, a width of 3.15 m, a height of 4.05 m, and a fully loaded weight of 40,900 kg. The TEL carries a crew of six and has a road speed of 60 km/hr.

A Russian Osa 2 class missile boat with four SS-N-2C Styx missile canisters (US Navy)

Specifications

	SS-N-2A	SS-N-2B	SS-N-2C/D/E	SSC-3
Length	5.2 m	5.8 m	6.5 m	6.5 m
Body diameter	0.76 m	0.76 m	0.78 m	0.78 m
Launch weight	2,100 kg	2,300 kg	2,500 kg	2,500 kg
Payload	350 kg	450 kg	513 kg	513 kg
Warhead	HE	HE	HE	HE
Guidance	Autopilot with active radar	Autopilot with active radar or IR	Autopilot with active radar or IR	Autopilot with Active radar or IR
Propulsion	Liquid Propellant	Liquid Propellant	Liquid Propellant	Liquid Propellant
Range	35 km	40 km	80 km	80 km
Accuracy	n/k	n/k	n/k	n/k

Operational status

The SS-N-2A 'Styx' was first test-flown in 1956, sea-launched in 1957 and entered service in 1960. SS-N-2B development started in 1958 and entered service in 1965. The SS-N-2C entered service in 1972. The coastal defence variant, SSC-3. entered service in 1978. It is believed that SS-N-2 missile production continued in Russia until 1988. SS-N-2 and SSC-3 missiles have been exported to the following countries: Algeria, Angola, Azerbaijan, Bulgaria, China, Croatia, Cuba, Egypt, Ethiopia, Finland, Georgia, Germany, India, Indonesia, Iran, Iraq, North Korea, Libya, Poland, Romania, Serbia, Somalia, Syria, Tunisia, Ukraine, Vietnam and Yemen. The coastal defence version, SSC-3, was widely deployed in Russia, but has almost certainly been replaced by more modern systems. It is believed that SSC-3 missiles are still deployed in Algeria, Libya, Syria and Yemen. Several countries have built 'Styx' under licence; China, Iraq and North Korea have also modified the basic 'Styx' design to their own variants. The first use of 'Styx' missiles was in 1967 when several Egyptian missiles were fired at and sank the Israeli destroyer *Eilat*, and in 1970 an Egyptian 'Komar' class boat sank an Israeli merchant ship. In 1971, Indian missiles sank a Pakistani destroyer and minesweeper, and also attacked oil facilities in Pakistan. During the 1980 to 1988 Iraq-Iran war, both countries used 'Styx' and 'Silkworm' missiles against ships and possibly against some shore targets as well.

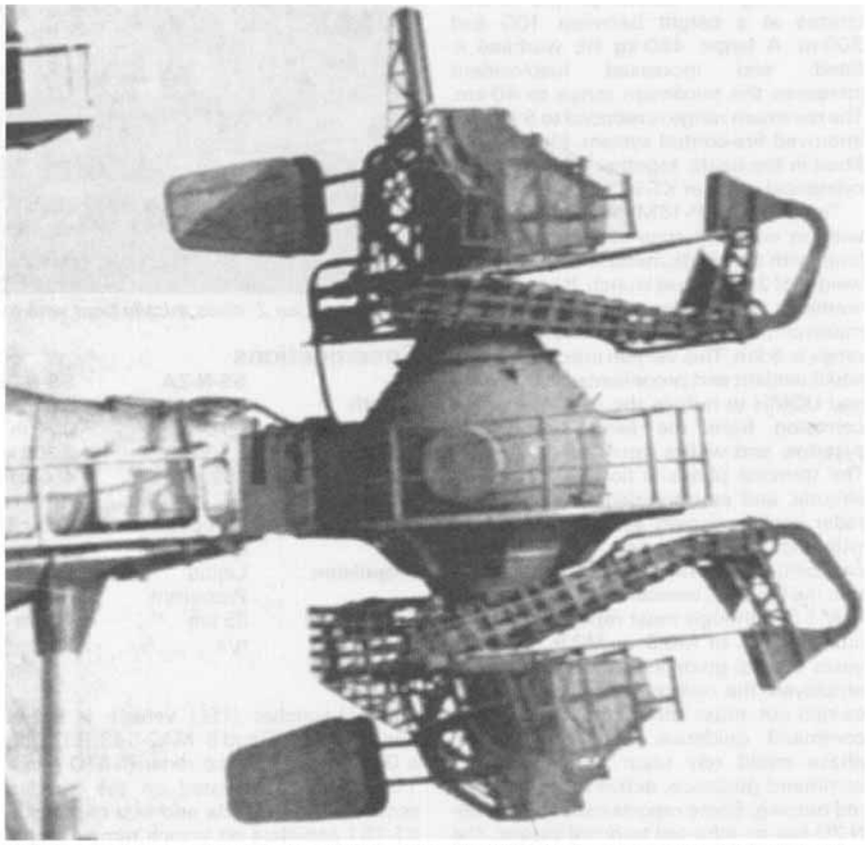
Contractor

The SS-N-2 'Styx' is believed to have been designed by the Mikoyan/Berezniak OKB-155, and is supported now by the Raduga NPO, Dubna.

SS-N-3 'Shaddock' (P-/6/7/10) and SS-N-3/SSC-1 'Sepal' (P-5/35)

Type
Short-range, ship-, submarine- and ground-launched, turbojet-powered, single-warhead surface-to-surface missiles.

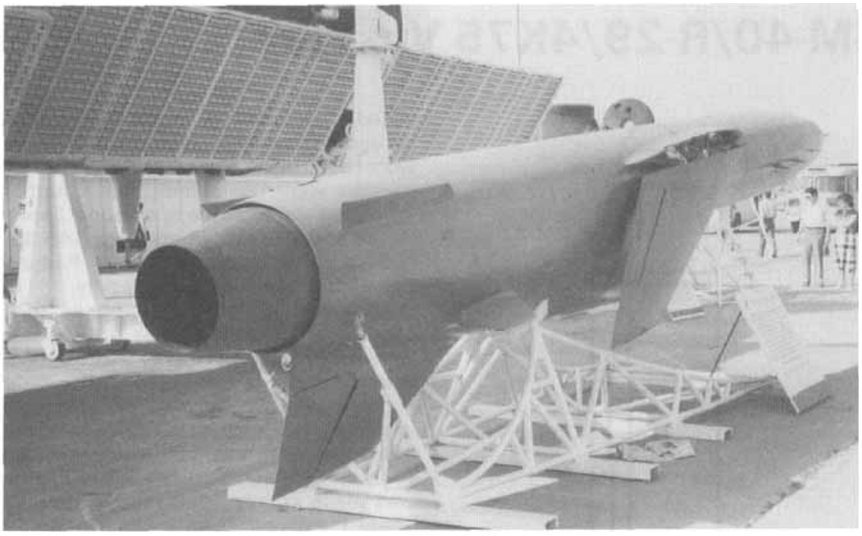
Development
The early SS-N-3 'Shaddock and 'Sepal' surface-to-surface missiles were developed in the late 1950s and early 1960s. and were reported to have entered service around 1963. There have probably been four versions of SS-N-3; the Russian designations are believed to be P-5 Pityorka, P-6, P-7, P-10 Progress (4M48) and P-35 Reduit (4M44). NATO has called the P-6 version SS-N-3A and the P-7 (9M12) is designated SS-N-3C, these two versions were submarine-launched and were carried by 'Echo 2' and 'Juliett' class submarines. The P-5 and P-35 have been called SS-N-3B 'Sepal' by NATO, and this is the ship-launched variant of the 'Shaddock missile system, although a Russian report indicates that the P-5 version was submarine launched. 'Sepal' is also carried by an eight-wheeled launcher vehicle when used for coastal defence, and has been given the NATO designator SSC-1B. Unconfirmed reports suggest that there were possibly further 'Shaddock and 'Sepal' versions developed, known in Russia as P-25. It is believed that some export missiles were built with the designator P-35E, and that these had a shorter range and weighed less than the standard missiles. The ship-launched SS-N-3B 'Sepal' missiles were installed in 'Kresta 1' and 'Kynda' class cruisers. The 'Kresta 1' cruisers carried eight 'Sepal' launchers; the 'Kynda' cruisers carried two quadruple 'Sepal' launchers, one forward and the other aft. The 'Echo 2' submarines carried eight launchers and 'Juliett' carried four. SS-N-3 'Shaddock and 'Sepal' missiles in Russian service have all been replaced by SS-N-12 'Sandbox', and there are no missiles left in service on board ships or submarines in Russia. A target drone and UAV version of SS-N-3 has been used by both Russia and Syria.



A 'Scoop Pair' fire-control radar, showing the two S-band antenna above and below the spherical housing

Description
SS-N-3 'Shaddock and 'Sepal' missiles are 10.8 m long, with a body diameter of 0.98 m. Two swept-wings unfold forwards after launch and have a span of 2.5 m. A turbojet engine is located in the rear body of the missile, with a scoop air inlet below the centre wing. The missile is boosted from the launch tube by two solid propellant motors attached together under the rear body of the missile, which are jettisoned after use, and the missile climbs steeply to its cruise altitude after launch. The missile can cruise at 100 m, 4,000 m, or 7,500 m altitude, at a speed at high level of M1.3. Following the boost phase a turbojet engine powers the missile for the remainder of the flight. Mid-course guidance is reported to be by radio command, with the missile and target tracked by a 'Scoop Pair' or 'Front Door' radar for shorter ranges, or by aircraft or helicopter for longer ranges. It is reported that Tu-16 'Badger', Tu-95 'Bear-D', Ka-25 'Hormone' and Ka-27 'Helix' have all been used with SS-N-3 'Shaddock and 'Sepal' missiles. The aircraft and helicopters could downlink their radar pictures to the ship or submarine launcher, so that the weapons control officer could plan the missile course and pre-programme the missile with target co-ordinates. Later upgrades used satellite surveillance data for the weapons control officer. In mid-course the missile has an inertial guidance system, with command updates. For the terminal phase it is believed that SS-N-3 descends and is controlled at low level by a radar altimeter, and that either Infra-Red (IR) or active radar terminal guidance is used. The missile launch weight, including solid boosters, is estimated to be 5,300 kg, with a payload of 870 kg, and the missile itself weighing 4,500 kg. It is reported that there can be a conventional HE SAP or a 10 kT nuclear warhead fitted. A later nuclear warhead option had a weight of 650 kg

The four forward launch canisters for SS-N-3B 'Sepal' missiles can be seen on this 'Kynda' class cruiser, with the four rear launchers just visible as the deck line drops



An SS-N-3B/SSC-1B 'Sepal'(P-5) missile displayed at Moscow Air Show in 1992. without the two solid propellant booster motors fitted and with the wings folded
(Christopher F Foss)

and a yield of 200 kT. The P-5, P-6 and P-35 were nuclear warhead versions. A maximum range of between 300 and 450 km has been reported for both 'Shaddock' and 'Sepal', and a minimum range of 25 km. It is possible that the longer range was obtained by using a lighter payload. The missiles were often fired in salvo, either two, three or four at a time, and each would datalink the radar picture from the terminal seeker back to the launch platform, so that a particular target could be designated for each individual missile.

The 'Scoop Pair' fire-control radar operates in S-band (3 GHz) and consists of two apparently identical radars mounted above and below a spherical housing supported at the end of a sponson. It is believed that these sponsons, which are aligned with the ship's fore and aft axis, may include provision for rotating the radar group to provide stabilisation against roll motion. The scanners, which are estimated to be approximately 4.2 m in span, are of open lattice construction and of essentially elliptical paraboloid form, although the contours are rather angular. They each have the typical Soviet balance vanes behind the scanners, in this case of almost square outline. Each scanner is illuminated by a double horn assembly carried on a boom, coming from beneath the scanner in the case of the upper radar group, and above in the case of the lower radar. The disposition of the horns suggests that they are arranged to provide maximum elevation coverage from the combined radars. 'Kresta I' class guided missile cruisers have a single installation, high on the main 'tower', this serves two twin launchers below and on each side of the bridge. 'Kynda' class ships have two groups, fore and aft, each serving a four-tube launcher.

'Front Door' fire-control radars are used on the 'Echo' and 'Juliett' submarines. This radar operates in S-band (3 to 4 GHz), and is located at the bows in a casing about 5 × 3 m. The antenna is folded away when not in use, being mounted on the underside of the deck panel and elevated to the upright position for use.

The coastal defence 'Sepal' missile system is carried and launched from an 8 × 8 wheeled Transporter-Erector-Launcher (TEL) converted from the BAZ-135, and the system is reported to have the Russian designation 4K95 or SPU-35V. The TEL has a length of 13.5 m, a width of 2.86 m, a height of 3.53 m and a loaded weight with its single missile of 21,000 kg. The TEL carries a crew of five, and has a road speed of 40 km/hr.

Operational status

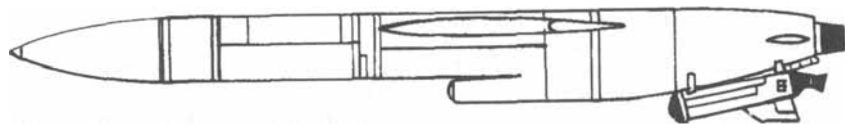
The first SS-N-3 'Shaddock and 'Sepal' missiles are believed to have entered service with the Russian Navy in 1963, and production probably continued until 1973. Three versions have been reported, and it is believed that some 190 SS-N-3C 'Shaddock' submarine-launched, SS-N-3B 'Sepal' ship-launched and coastal defence versions remained in service in 1991. In 1991 the missiles were carried by three 'Echo 2' class submarines, one 'Kresta I' and three 'Kynda' cruisers. All Russian SS-N-3 ship- and submarine-launched missiles were removed from service by 1994. A coastal defence 'Sepal' missile was tested by Russia in the Black Sea in April 2000. Ship-launched SS-N-3B 'Sepal' missiles are believed to be in service with Serbia and Ukraine. It is also believed that the coastal defence SSC-1B version of 'Sepal' was exported to Angola, Bulgaria and Syria.

Specifications

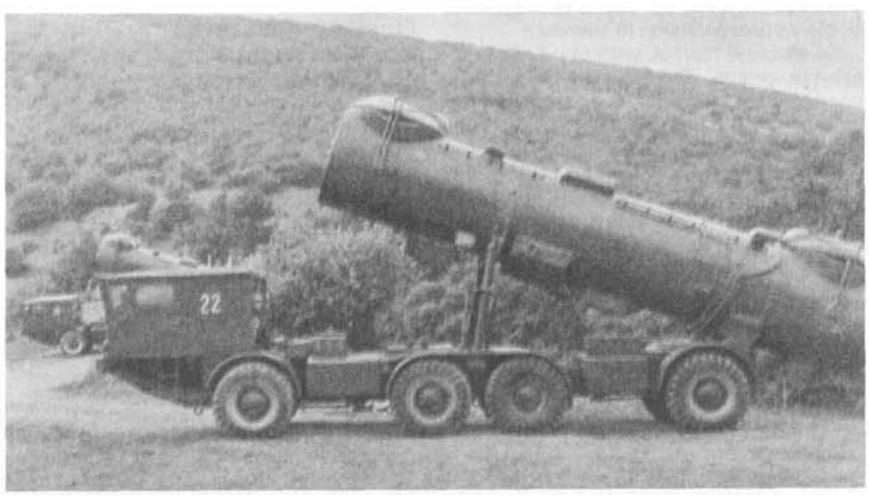
SS-N3C 'Shaddock' and SS-N9B 'Sepal'
Length: 10.8 m
Body diameter: 0.98 m
Launch weight: 5,300 kg
Payload: Single warhead; 650 or 870 kg
Warhead: HE SAP or nuclear 10 or 200 kT
Guidance: Inertial with commands and IR or active radar
Propulsion: Solid boosters and turbojet
Range: 300 or 450 km
Accuracy: n/k
Associated radars
Engagement radar: 'Scoop Pair'
Frequency: 3 GHz (S-band)
Range: n/k
Engagement radar: 'Front Door'
Frequency: 3-4 GHz (S-band)
Range: 55 km

Contractor

SS-N-3 'Shaddock and 'Sepal' were designed by the Chelomei Design Bureau, but are now supported by KBM, at Kolomna.



A line diagram of the SS-N-3 'Shaddock,and 'Sepal' missile **NEW0116331**



A ground-mobile coastal defence SS-N-3B 'Sepal'surface-to-surface missile launch vehicle

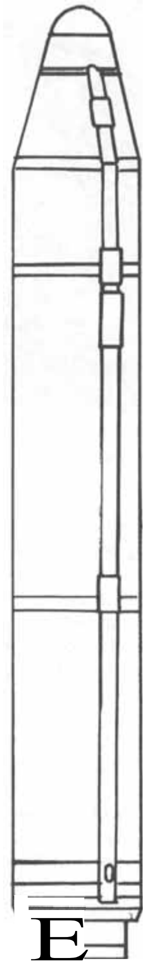
SS-N-8 'Sawfly' (RSM-40/R-29/4K75 Vysota)

Type
Inter-continental-range, submarine-launched, liquid-propellant, Multiple Re-entry Vehicle (MRV)-capable ballistic missile.

Development
The SS-N-8 was originally thought to be a development of the SS-N-6, but is now believed to have been a new missile, partly because it was the first Russian Submarine-Launched Ballistic Missile (SLBM) to utilise stellar sensing techniques to enhance its accuracy. A further reason is the greater length of the missile, which could only be accommodated in a new boat. The SS-N-8 began development in 1961, and entered operational service in 1973. The missile has the Russian designator RSM-40 (or R-29D and 4K75) and the name Vysota. The complete system was designated the D-9 complex. There were two versions, known as Mod 1 and Mod 2, the second version having considerably greater range and being more accurate. It was thought that the Mod 2 version had two RVs, but this has not been confirmed and Russian reports indicate that both versions had just single warheads. The SS-N-8 was fitted in the 'Delta 1' (type 667B) and 'Delta 2' class (type 667BD) submarines, with 12 missiles carried by the 'Delta 1' and 16 missiles by the 'Delta 2' boats. The Russian name for the 'Delta 1' submarines is 'Murena' and 'Murena-M' for the 'Delta 2' class.

Description
The SS-N-8 is a two-stage, liquid-propellant, inter-continental-range missile, 13.9 m long and with a diameter of 1.8 m. The launch weight is 33,300 kg. The minimum range is around 1,800 km, the maximum range of the Mod 1 is 7,800 km; and the Mod 2 maximum range is 9,100 km. The Mod 1 carries a single 1 MT nuclear warhead and the Mod 2 carries a single 800 kT nuclear warhead. In 1991, the Russians declared the throw weight of SS-N-8 to be 1,150 kg, with only the Mod 2 single warhead version in service.

Guidance is inertial, with star-tacking to provide updates. The use of stellar sensing improved the accuracy over the previous generation of missiles, and the SS-N-8 is estimated to have an accuracy of 1,500 m CEP for the Mod 1 version and 900 m CEP for the Mod 2. The SS-N-8 uses Unsymmetrical Dimethyl Hydrazine (UDMH) and nitrogen tetroxide liquids, with a maximum first stage burn time of 150 seconds and a second stage burn time of 80 seconds. The missiles can be launched from a submerged depth down to 50 m.



A line diagram of the SS-N-8 'Sawfly' missile 0038264

Operational status
The SS-N-8 Mod 1 was first operational in 1973 with Mod 2 entering service in 1974. The missile was deployed in the 'Delta 1' and 'Delta 2' boats. At its peak deployment there were 18 'Delta 1' and four 'Delta 2' boats, with 280 operational missiles. In 1991, there were 15 'Delta 1' boats and four 'Delta 2' in service, with 12 missiles carried by the 'Delta 1' and 16 missiles by the 'Delta 2'. The 'Delta 1' boats were based at Rybachiy (3 boats), Pavlovskoye (3) and Ostrovnoy (9). The 'Delta 2' boats were based at Yagelnaya (4). A total of 244 missiles were operational, but a further 177 were stored at the operational bases, Revna and Okolnya. In addition, 146 SS-N-8 missiles were at the Pashino conversion/elimination facility. In December 1994 there were 222 operational missiles, in July 1997 there were 192 missiles, in January 2000 there were 64 missiles, and in July 2002 there were believed to be 12 missiles operational in the last remaining boat. The status of the non-operational missiles is unclear. An operational test launch of an SS-N-8 missile was made in July 1996. There were 12 'Delta 1' and four 'Delta 2' boats in service in 1996, but by January 1999 these had reduced to just 4 'Delta 1' boats with 48 missiles. By June 2002 there remained just one 'Delta 1' boat in service, although the missiles may have been removed.

'Delta 1' submarines were proposed as launch platforms for a 'Vysota' satellite launch vehicle in 1994, capable of orbiting a 130 kg payload into a 250 km circular orbit, using the two-stage liquid-propellant SS-N-8 'Sawfly' missile. However, nothing more has been heard about this proposal, and it is assumed that the missiles will be destroyed as they are removed from service.

Specifications
SS-N-8 Mod 1
Length: 13.9 m
Body diameter: 1.8 m
Launch weight: 33,300 kg
Payload: Single warhead
Warhead: Nuclear 1 MT
Guidance: Inertial with stellar reference
Propulsion: 2-stage liquid
Range: 7,800 km
Accuracy: 1,500 m CEP

SS-NS Mod 2
Length: 13.9 m
Body diameter: 1.8 m
Launch weight: 33,300 kg
Payload: Single warhead
Warhead: Nuclear 800 kT
Guidance: Inertial with stellar reference
Propulsion: 2-stage liquid
Range: 9,100 km
Accuracy: 900 m CEP

Contractor
The SS-N-8 was designed by the Makeyev Design Bureau.

SS-N-8 'Sawfly' being carried on a transporter vehicle during a parade

SS-N-9 'Siren' (P-50/P-120/4K85 Malaxit)

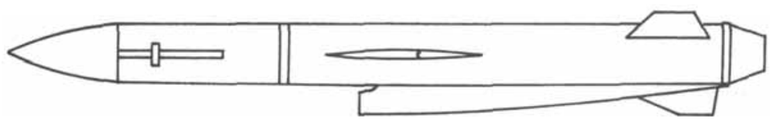
Type

Short-range, ship- and submarine-launched, solid-propellant, single-warhead surface-to-surface missile.

Development

The SS-N-9 'Siren' was developed from 1963 to 1974 as an improvement to the SS-N-7 'Starbright', but there was some confusion between the two as the SS-N-9 was seen by NATO before the SS-N-7. It is believed that the Russian designator for the initial SS-N-9 is P-50 or 4K85 Malaxit. An improved version of the missile has the designator P-120, and this may have been introduced for use from submarines. The SS-N-9 was designed to be used against large ships, and appears to have been a scaled-down version of the SS-N-3 'Shaddock/Sepal' missile for use from smaller ships and submarines. SS-N-9 has a better performance than SS-N-7, as it includes provision for mid-course updates from airborne platforms. The SS-N-9 has been fitted to 'Nanuchka 1 and 3' and 'Tarantul 2 and 3' class corvettes in six-launch canisters, to 'Sarancha' class hydrofoils in four-launch canisters, as well as to 'Charlie 2' and 'Papa' class submarines with eight and 10 missiles carried respectively. The SS-N-9 has been succeeded by the SS-N-22 'Sunburn'. Reports in 1995 suggested that a further improved version of the SS-N-9 missile was in development in Russia, with the provisional NATO designators SS-NX-26 and SSC-X-5 (see separate entry). However, it is now clear that the SS-NX-26 missile is a new design, based upon the SS-N-19 and not the SS-N-9.

A 'Nanuchka 1 'class corvette with two triple SS-N-9 'Siren' launch canisters, with a Band Stand' radome just forward of the main mast and a smaller Fish Bowl' command link radome beside the mast 0003142



*A line diagram **of** the **SS-N-9** missile*

Description

The SS-N-9 missile is 8.84 m long, has a body diameter of 0.8 m and a launch weight of 3,300 kg. The wing span is 2.5 m when the delta wings are extended. The shape of the missile is similar to that of the SS-N-3, with a scoop air inlet under the centre of the wings. It is believed that the missile has inertial mid-course guidance, with either an active radar X-band (10 GHz) or an Infra-Red (IR) terminal seeker. The engagement radar is the 'Band Stand', which operates in S-band (3 to 4 GHz), and the antenna is housed in a conspicuous radome situated on top of the bridge of the 'Nanuchka' or 'Tarantul' corvettes. Two small radomes on either side of 'Band Stand' are believed to be the command link antenna for SS-N-9 and these are called 'Fish Bowl' or 'Light Bulb'. For the longer ranges, mid-course guidance updates are provided by Ka-25 'Hormone B' or Ka-27 'Helix B' helicopters, giving a maximum range of 110 km, otherwise the system range is limited to around 70 km. The SS-N-9 missile has a 500 kg warhead, which can be either conventional High Explosive (HE) or 200 kT nuclear. The missile has a solid propellant boost motor fitted underneath the rear body that is jettisoned after launch, and a turbojet engine for cruise. The missile cruises at 60 m altitude with a radar altimeter, and has a cruise speed of M0.9.

Operational status

SS-N-9 'Siren' is believed to have entered service with the Russian Navy in 1969, with the improved version introduced in 1977. The missiles are fitted to Ukrainian ships, and in 1995 it was reported that P-120E (export) SS-N-9 missiles were being sold to India for fitment to their 'Delhi' class destroyers. The exported 'Nanuchka' class corvettes were fitted with SS-N-2 'Styx' missiles. In 1991, it was believed that about 250 SS-N-9 missiles remained in service, fitted to: six 'Charlie 2' class Nuclear-Powered Cruise Missile Submarines (SSGN); 16 'Nanuchka 1'; and 17 'Nanuchka 3' class missile corvettes. By 1996, the Russian Navy had only three 'Charlie 2' boats in service, 12 'Nanuchka 1' and 18 'Nanuchka 3' corvettes, and by 2002 these had reduced to just 12 'Nanuchka 3' corvettes.

Specifications

Length: 8.84 m
Body diameter: 0.8 m
Launch weight: 3,300 kg
Payload: Single warhead; 500 kg
Warhead: HE or 200 kT nuclear
Guidance: Inertial with updates and active radar or IR
Propulsion: Solid propellant and turbojet
Range: 110 km
Accuracy: n/k

Associated radars
Engagement radar: 'Band Stand'
Frequency: 3-4 GHz (S-band)
Range: n/k

Contractor

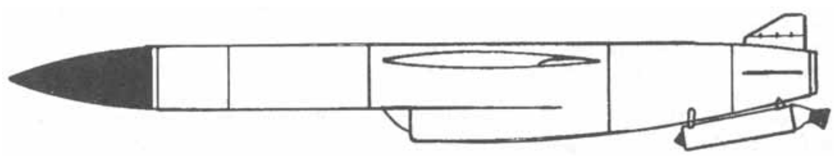
SS-N-9 is believed to have been designed by the Chelomei Design Bureau, and is supported by KBM at Kolomna.

SS-N-12 'Sandbox' (P-500/4K80 Bazalt)

Type
Intermediate-range, ship- and submarine-launched, turbojet-powered, single-warhead surface-to-surface missile.

Development
The SS-N-12 'Sandbox' is considered to be a second-generation anti-ship cruise missile system, following on from the first-generation SS-N-3 'Shaddock' and 'Sepal' systems. The missile has the Russian designators P-500 and 4M80, and the system has the designator 4K80 Bazalt. Development started in 1963, with the first test flight in 1969, and the missile entered service in 1975. SS-N-12 was an upgraded 'Sepal' (P-35) with small external changes, notably with the engine air inlet moved forward towards the wing leading edge. An improved SS-N-12 version entered service in 1983, and the SS-N-12 was replaced by the third-generation system, SS-N-19 'Shipwreck'. 'Sandbox' was fitted to the single 'Modified Kiev' class *Admiral Gorshkov* carrier with 12 launch canisters, in the 'Slava' class guided missile cruisers with 16 launchers, in 'Echo 2' class submarines with eight launchers and in 'Juliett' class submarines with four launchers.

A Russian 'Slava' class guided missile cruiser with 16 SS-N-12 Sandbox missile launch canisters The 'Top Steer' surveillance radar antenna can be seen on top of the foremast structure. with 'Front Door' below on the bow face of the structure



A line diagram of an SS-M-12 missile **NEW**/0116332

Description
It is believed that the SS-N-12 missile is an upgraded SS-N-3, with some external and internal improvements. The missile is 11.7 m long, has a body diameter of 0.88 m, an extended wingspan of 2.6 m, and a weight of 4,800 to 5,000 kg at launch. Some reports suggested that the missile has command mid-course guidance, followed by active radar terminal guidance; however, it is believed that the mid-course guidance is inertial with optional command updates. The missile can use its active radar at high altitude to detect the target, then switch the radar off and descend to low level, making a final search for the target late in the terminal phase. Tu-95 'Bear-D', Ka-25 'Hormone' and Ka-27 'Helix' could be expected to provide command updates, in a similar way to their use with the earlier SS-N-3 'Shaddock systems. SS-N-12 'Sandbox' has a solid propellant booster motor located under the rear body, which is jettisoned after use. A KR 17-300 turbojet engine is used for the rest of the flight. The missile can cruise at high level, between 10 and 15 km altitude, when it has a maximum speed of M2.5. At low level the missile cruises at M0.8, and for the terminal phase the missile descends to an altitude of 50 m and then dives down onto the target. The missile payload is believed to be around 1,000 kg, with 350 kT nuclear or conventional High Explosive (HE) warheads. The 'Sandbox' missile is reported to have a range of 550 km, and to be capable of either high or low altitude cruise profiles. An accuracy of 300 to 700 m CEP has been reported.

The 'Front Door' engagement radars operate in S-band (3 to 4 GHz) and there are three basic versions in service, 'Front Door A, B and C'. 'Front Door **A'** is fitted to the 'Echo' class submarines and is similar to the radar used for SS-N3C 'Shaddock missiles. 'Front Door B' is fitted to the 'Kiev' class and is housed on the underside of a 5 × 3 m casing, which is raised to the upright position when required for use. 'Front Door C', originally called 'Trap Door', is fitted to the 'Slava' class and is mounted high on the front of the main structure just below the 'Top Steer' **3-D** surveillance radar antenna. 'Front Door C′ has a rectangular mesh antenna, with a horn feed at the top. It is believed that the 'Front Door' radars track the missiles in flight, and are used to provide mid-course updates to the missiles.

Operational status
SS-N-12 'Sandbox' missiles are believed to have entered service in 1975, and some 400 missiles remained in service in 1991. It is known that the 'Modified Kiev' carrier had reload missiles on board, believed to be two reloadsfor each launcher, making a total of 36 missiles. In 1991, there were 14 'Echo 2'. 15 'Juliett' submarines, four 'Kiev' and 'Modified Kiev' class aircraft carriers, and three 'Slava' class cruisers in service; all believed to be carrying SS-N-12 'Sandbox' missiles. By the end of 1995, these numbers had reduced to three 'Echo 2', one 'Juliett' submarine, one 'modified Kiev' aircraft carrier and three 'Slava' cruisers; as a result it is believed that the number of SS-N-12 missiles remaining operational had reduced to around 150. By early 2000 there were just three 'Slava' class cruisers in service with SS-N-12 missiles, with around 50 missiles still operational in the Russian Federation. SS-N-12 missiles are not fitted to Ukrainian ships, but a fourth 'Slava' class cruiser is being completed for Ukraine and this may be fitted with SS-N-12 missiles.

Specifications
Length: 11.7 m
Body diameter: 0.88 m
Launch weight: 4,800 to 5,000 kg
Payload: Single warhead; 1,000 kg
Warhead: 350 kT nuclear or conventional HE
Guidance: Inertial with command updates and active radar
Propulsion: Solid propellant boost and turbojet
Range: 550 km
Accuracy: 300 to 700 m CEP

Associated radars
Surveillance radar: 'Top Steer' 3D
Frequency: 1-3 GHz (L-band)
Range: n/k
Engagement radar: 'Front Door'
Frequency: 3-4 GHz (S-band)
Range: 55 km

Contractor
It is believed that SS-N-12 'Sandbox' was designed by the Chelomei Design Bureau, and is now supported by KBM at Kolomna.

SS-N-14 'Silex' (83R/UPRK-3 Metel, 84R/UPRK-4 Metel, 85RU/URK-5 Rastrub)

Type

Short-range, ground-launched and ship-launched, anti-submarine and anti-ship, solid-propellant, single-warhead, surface-to-surface missiles.

Development

Although reported as having entered service in 1969, very little was known about the development of this anti-submarine weapon, believed to have had the Russian designators 83R/UPRK-3 Metel, 84R/UPRK-4 Metel, and 85RU/URK-5 Rastrub. Initially it was given the NATO designator SS-N-10, but this was changed to SS-N-14 'Silex'. It was primarily designed to deliver a homing torpedo against submarine targets, but it has a secondary capability against surface ships. The 83R missile was fitted to cruisers and entered service in 1969, and the 84R was fitted to frigates and entered service in 1973. The 85RU version has an additional warhead fitted, to enhance its performance against surface ship targets, and this version entered service in 1976. The 'Silex' has been fitted to the *Admiral Ushakov* (ex-Kirov) battle cruiser in a twin-launch canister, cruisers of the 'Kara' (project 1134B) and 'Kresta 2' class with eight missiles in two quadruple launchers, destroyers of the 'Udaloy 1' (project 1155) class with eight missiles in two quadruple launchers, and frigates of the 'Krivak 1 and 2' (projects 1135 and 1135M) class with four missiles in a quadruple launcher on the bows. In 1993, an upgraded version, designated YP-85, with a range of 250 km, was proposed for export.

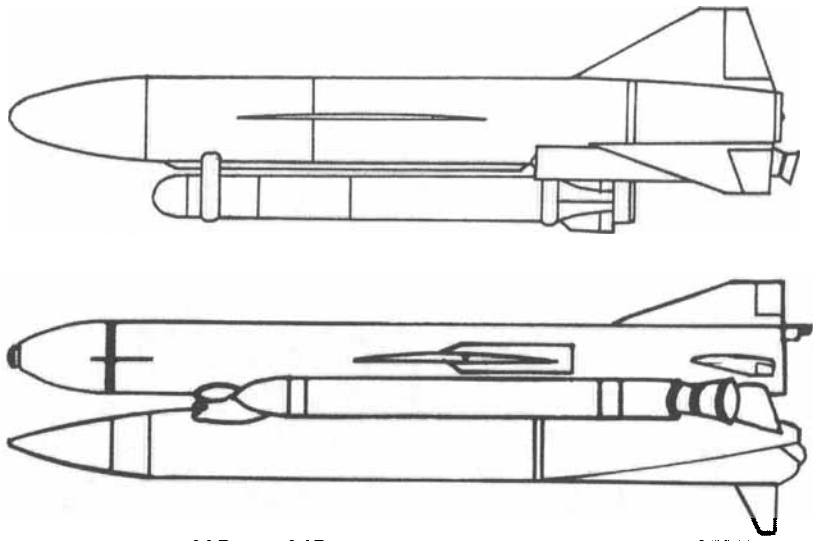
Two Eye Bowl engagement radars, used for tfie SS-N-14 missile system 0003144

Description

SS-N-14 'Silex' is believed to be a winged missile similar in shape to SS-N-2 'Styx', and similar in concept to the French 'Malafon' or the Australian 'Ikara'. The missile carries a torpedo underneath. The earlier versions of the SS-N-14 missile, with the Russian designators 83R and 84R, are 7.2 m long, have a height of 1 35 m, a body diameter of 0.55 m and weigh 3,700 kg at launch. The wings and fins are folded in the launch canister. Guidance is believed to be by autopilot and command updates from the surveillance and tracking radars When the missile reaches the approximate position of the target submarine, the torpedo is dropped by parachute. Once it strikes the surface of the water, the torpedo is separated from the parachute and begins its search phase. There have been two principal torpedoes used by 'Silex' missiles. The 83R version uses an AT-I torpedo, NATO designator EA45-70A, which has a length of 4.7 m, a diameter of 0.45 m, a 90 kg High Explosive (HE) warhead, an active sonar seeker, a speed of 28 kt, a maximum depth of 300 m, and a range of 8 km. The 84R 'Silex' missile version uses an AT-2 torpedo, NATO designator E53-72, which has a diameter of 0.53 m, a 100 kg HE warhead, an active/passive sonar seeker, a speed of 40 kt, a maximum depth of 400 m, and a range of 8 km. It is believed that the 84R torpedo, E53-72, may also have had an optional 5 kT nuclear warhead. Reports indicate that the 'Silex' missile has a dual capability against both submarine and surface ship targets. The missile has a solid propellant motor, which gives it a minimum range of 5 km, a maximum range of 55 km, and a cruising speed of M0.95 at 750 m altitude. The 83R version has the Grom-M fire-control system, fixed quadruple KTM-1134 launchers, and 'Headlights B' engagement radar. The 84R version has the Musson fire-control system, trainable quadruple KTM-1135 launchers, and the 'Eye Bowl' engagement radar.

An improved version, 85RU/URK-5 Rastrub, has a 185 kg high explosive semi-armour-piercing warhead located in front of the torpedo. This warhead gives SS-N-14 'Silex' an improved capability against surface ships, and is fitted to a modified 'Silex' carrier missile with an infra-red seeker. The infra-red seeker is required for terminal guidance, and both the HE-SAP warhead and torpedo hit the target ship still attached to the carrier missile. It is believed that a modified version, known as 85RUS, had a nuclear warhead. The 85RU version has two large solid-propellant boost motors that run three-quarters of the length of the missile between the missile and torpedo, with a total body height of 1.35 m. The sustainer motor is also solid propellant. The 'Silex' missile is believed to cruise at 15 m altitude, and to dive down onto the target ship. This improved version has a length of 7.2 m, a missile carrier body diameter of 0.57 m, and a launch weight of 3,930 kg. The 85RU has a minimum range of 5 km and a maximum range of 50 km, and a cruise speed of M0.9. The missile can be pre-selected before launch to attack a submarine or ship target. When used against submarine targets the missile cruises at 400 m altitude, and at a command from the launch ship a parachute deploys and the torpedo separates from the carrier missile and enters the water. The torpedo can be an AT-2 or a UGMT-1, NATO designator E45-75A, with a length of 3.9 m, a diameter of 0.41 m, a warhead weight of 60 kg HE, an

A Russian Navy 'Udaloy' class destroyer with the starboard quadruple SS-N-14 'Silex' launcherjust forward of the bridge (US Navy)



Line diagrams of the 83R and ***84R*** *missile configuration* ***(top),*** *and the 85RU version (below)*
0038265

active/passive sonar seeker, a speed of 40 kt, a maximum depth of 500 m, and a range of 8 km. The fire-control system is the Drakon, with quadruple KTR-1134A launchers. The launchers are usually loaded with two anti-ship and two anti-submarine missiles, and have hydraulically opening doors at the front and rear.

It is believed that the 'Headlights B' C-band (4 to 8 GHz) or 'Eye Bowl' S-band (3 to 4 GHz) radar tracks the 'Silex' missile, with command updates to the missile transmitted as coded information within the radar transmission. There appear to be electro-optical sensors mounted behind the antenna for tracking in jamming conditions. 'Eye Bowl' is used on the *Admiral Ushakov* and 'Udaloy' and 'Krivak class ships. The 'Kara' and 'Kresta II' ships use the 'Headlights B' radar, which it is believed was initially designed for the SA-N-3 'Goblet' SAM system, but was assigned a dual role with 'Silex'.

Operational status

The SS-N-14 'Silex' (83R) entered service with the Russian Navy in 1969, the 84R in 1973 and the 85RU in 1976. Other than Ukraine there are no known exports. In 1991, it was believed that about 365 missiles remained in service, fitted to: one 'Kirov' class battle cruiser; seven 'Kara' class cruisers; 10 'Kresta 2' cruisers; 12 'Udaloy 1' destroyers; 21 'Krivak 1'; and 11 'Krivak 2' frigates. By late 1995, these numbers had reduced to: one 'Kirov' class battle cruiser; five 'Kara' cruisers; 11 'Udaloy 1' destroyers; 15 'Krivak 1'; and 10 'Krivak 2' frigates.

By June 2002 these numbers had reduced to one 'Kara' battle cruiser, seven 'Udaloy 1' destroyers, six 'Krivak 1' and two 'Krivak 2' frigates. The total SS-N-14 missiles in service with the Russian Federation has probably reduced to about 100.

Specifications

83R and 84R
Length: 7.2 m
Body diameter: 1.35/0.55 m
Launch weight: 3,700 kg
Payload: Single torpedo or depth charge
Warhead: HE or nuclear 5 kT
Guidance: Autopilot and command updates
Propulsion: Solid propellant
Range: 55 km
Accuracy: n/k

85RU
Length: 7.2 m
Body diameter: 1.35/0.57 m
Launch weight: 3,930 kg
Payload: HE/SAP 185 kg and torpedo
Warhead: HE or nuclear
Guidance: Inertial and command updates with IR
Propulsion: Solid propellant
Range: 50 km
Accuracy: n/k

Associated radars
Engagement radar: 'Eye Bowl'
Frequency: 3-4 GHz (S-band)
Range: 55 km
Engagement radar: 'Headlights B'
Frequency: 4-8 GHz (C-band)
Range: 60 km

Contractor

The SS-N-14 'Silex' missile is believed to have been designed by the Raduga NPO, Dubna, and the fire-control system by Altair NPO, Moscow. The missiles were built by the Smolensk Aircraft Plant.

SS-N-15 'Starfish' (81R/RPK-2 Vyuga, 90-RU Tsakra)

Type
Short-range, submarine-launched, solid-propellant, single-warhead, anti-submarine missile.

Development
Little is known about the development of the SS-N-15 'Starfish', except it is reported that the Russians benefited from copying the design of the US UUM-44 Submarine-launched Rocket (SUBROC). 'Starfish' is believed to have entered service with the Russian Navy in 1969, and is believed to have the designator 81R (or RPK-2 Vyuga). The improved 90-RU Tsakra version is believed to have entered service in 1981.

The SS-N-I5 is or has been carried by 'Kirov' (project 1144) class battle cruisers, 'Udaloy 2' (project 1155.1) class destroyers, 'Neustrashimy' (project 1154) class frigates, 'Typhoon' (project 941). 'Charlie 1/2', 'Delta 4') project 667BDRM), 'Oscar 1/2' (project 949). 'Victor 1/2/3' (project 671), 'Alfa', 'Sierra 1/2' (project 945) and 'Akula 1/2' (project 971) class submarines. 'Romeo' and 'Tango' class diesel attack submarines may also have been capable of firing 'Starfish'. A report in 1999 suggested that an improved SS-N-15 missile would be fitted to 'Yasen' class (type 885) attack submarines. It is reported that each submarine is allocated an average of four Anti-Submarine Warfare (ASW) nuclear weapons, either SS-N-15 or SSN-16.

Description
SS-N-15 'Starfish' is believed to be similar in shape and size to the US UUM-44 SUBROC, but has four lattice-type control fins at the rear, similar to those seen on some Russian ballistic and air-to-air missiles. The SS-N-15 (81R/RPK-2 version) is 6.9 m in length, has a body diameter of 0.53 m and a weight of 1,800 kg. The depth charge warhead is reported to be 200 kT nuclear, but could also be conventional High Explosive (HE) weighing around 300 kg. The weapon is launched horizontally by standard 533 mm (21 in) torpedo tubes from the submerged submarine, at depths down to 50 m. The missile then follows a short underwater path before breaching the surface to follow an airborne path to the target area. On reaching the target area, the depth charge is released to continue on a ballistic trajectory until it enters the water near the target, sinking to the optimum depth before detonation. The maximum depth is reported to be 350 m. This type of weapon relies upon accurate location of the target, followed by rapid launch and flight to the target area before the target has time to travel too far from its last known position. The missile is controlled by a Granit Central Scientific Research Institute fire-control system, which also controls the torpedoes. It is believed that this fire-control system has the name 'Purga'. The solid propellant motor gives the missile a maximum range of 35 km and a minimum range of 10 km.

There are no details available for the later 90-RU (Tsakra) version of the missile.

Operational status
The SS-N-15 'Starfish' (81R) is reported to have been in service with the Russian Navy since 1969. The later version, 90-RU is believed to have entered service in 1981, and a third version may have been developed in the late 1980s and early 1990s. It is believed that about 400 SS-N-15 remained in service in 1991, probably reduced to 300 by the end of 1995, and to 190 by the end of 1998. There are no known exports.

In 2002 it is likely that the SS-N-I5 is carried by around 30 Russian submarines, including 'Typhoon', 'Delta 4'. 'Sierra 2'. 'Victor 3'. 'Oscar 2' and 'Akula' class boats, with two 'Kirov' class battle cruisers, one 'Udaloy 2' class destroyer and one 'Neustrashimy' class frigate.

Specifications
Length: 6.9 m
Body diameter: 0.53 m
Launch weight: 1,800 kg
Payload: 300 kg single-warhead depth charge
Warhead: Nuclear 200 kT or HE
Guidance: Inertial
Propulsion: Solid propellant
Range: 35 km
Accuracy: n/k

Contractor
It is believed that the SS-N-15 'Starfish' was designed by OKB-8, now Novator NPO, Yekaterinburg.

A Russian 'Oscar' class submarine, which can carry SS-N-15 missiles
(Soviet Military Power) 0062335

A line diagram of the SS-M-15 missile
NEW/0116333

SS-N-16 'Stallion' (86R/RPK-6, 88R/RPK-7 Vodopad/ Veder, 1OORU)

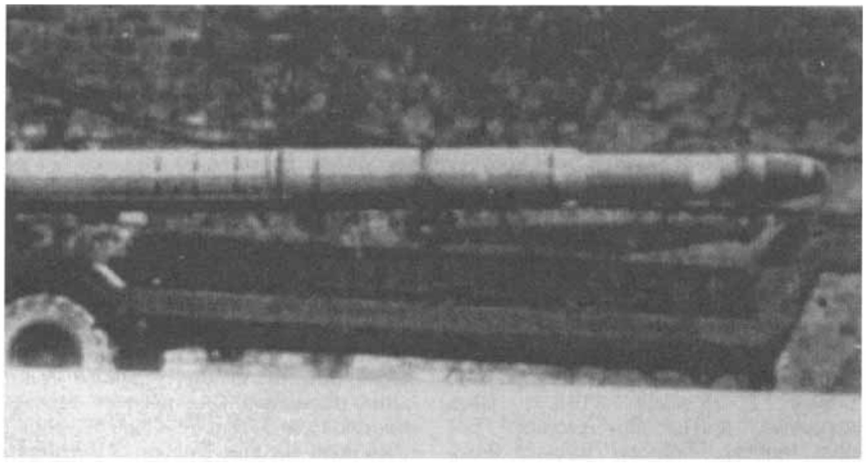
Type

Short-range, ship- or submarine-launched, solid-propellant, single-warhead, anti-submarine missiles.

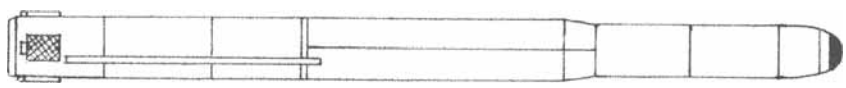
Development

Little is known about the development of SS-N-16 'Stallion'. It reportedly entered service with the Russian Navy in 1981 and was believed to be a further development of the SS-N-I5 'Starfish', in order to produce a torpedo delivery weapon similar to the US Anti-Submarine Rocket (ASROC), but fired from ships and submerged submarines. It is reported that the Russian designators for the original system are 86R/RPK-6 Vodopad/Veder, for an improved version 88R/RPK-7 Vodopad/ Veder, and for the latest version 100RU Vodopad/Veder.

The SS-N-16 'Stallion' is believed to have been deployed in 'Typhoon' (project 941). 'Delta 4' (project 667BDRM) 'Oscar 1/2' (project 949). 'Victor 2/3' (project 671). 'Sierra 1/2' (project 945) and 'Akula 1/2' (project 971) class submarines. The missiles can also be launched from surface ships and are fitted to 'Kirov' (project 1144) class battle cruisers, 'Udaloy 2' (project 1155.1) class destroyers and 'Neutrashimy' (project 1154) class frigates with six missiles per ship. It is estimated that each submarine is allocated an average of four Anti-Submarine Warfare (ASW) weapons, either SS-N-15 or SS-N-16.



An SS-N-16 'Stallion' ship- or submarine-launched anti-submarine missile on a wheeled transporter vehicle



A line diagram of the SS-N-16 'Stallion' missile *NEW*/0116334

Description

The SS-N-16 'Stallion' is thought to be similar in concept to the US UUM-44 Submarine-launched Rocket (SUBROC) and developed from SS-N-15 'Starfish', except that 'Stallion' carries a torpedo instead of a depth charge. The SS-N-16 (the earlier 86R version) is 8.17 m in length, has a body diameter of 0.53 m and weighs 2,445 kg. The torpedo can be either a Type 65, or an E45-75A. The type 65 torpedo has a range of 60 km and a speed of 50 kt; this torpedo has a High Explosive (HE) warhead believed to be 100 kg. The E45-75A torpedo has a length of 3.9 m, a 60 kg HE warhead, an active/ passive sonar seeker, a speed of 40 kt, a maximum depth of 500 m, and a range of 8 km. When carrying these HE warhead torpedoes the missile is known as Veder. It is reported that when carrying a nuclear warhead torpedo the missile is known as Vodopad. After launch from the torpedo tube the missile follows a short underwater path before broaching the surface to follow an airborne trajectory to the target area. During flight the missile is controlled by four lattice-type fins at the rear, similar to those developed for some Russian ballistic and air-to-air missiles. On reaching the target area the solid-propellant motor is jettisoned and the torpedo descends to the water by parachute, where it is automatically activated into its own search and track pattern. This type of weapon relies upon an accurate location of the target, followed by rapid launch and flight to the target area before the target has time to travel too far from its last known position. The 86R system uses Skat 1/2/3, NATO codename 'Shark Gill', sonar in submarines, and Polinon (NATO codename 'Horse Jaw') in surface ships. The maximum range of SS-N-16 (86R version) is reported to be 50 km, and the minimum range 10 km.

The second version of SS-N-16 (88R) has an increased diameter of 0.65 m and carries an ET-80 torpedo with an HE warhead and a range of 8 km. This version can only be fired through the larger 650 mm diameter torpedo tube. The 88R version is believed to have a weight of 2,850 kg at launch. It has a maximum range increased to 120 km, and a minimum range of 10 km. The third missile version, 100RU, has a maximum range increased to 200 km.

Operational status

The SS-N-16 'Stallion' (86R version) missiles entered service in 1981, the 88R version entered service in 1984, and the 100RU version entered service in 1989. Missile upgrades or life-expired assemblies may still be in limited production. It is believed that around 200 SS-N-16 missiles were in service in 1991, fitted to about 65 Russian submarines and ships. It seems likely that the number of missiles had reduced to 120 in service by June 2002, fitted to 30 submarines, including 'Typhoon', 'Delta 4', 'Sierra 2'. 'Victor 3'. 'Oscar 2', and 'Akula' class boats, with two 'Kirov' class battle cruisers, one 'Udaloy 2' class destroyer, and one 'Neutrashimy' class frigate. There are no known exports.

Specifications

Length: 8.17 m
Body diameter: 0.53 m (86R), 0.65 m (88R/1OORU)
Launch weight: 2,445 kg (86R), 2,850 kg (88R/1OORU)
Payload: Torpedo
Warhead: 60 kg HE or nuclear
Guidance: Inertial
Propulsion: Solid propellant
Range: 50 km (86R), 120 km (88R), 200 km (1OORU)
Accuracy: n/k

Contractor

It is believed that SS-N-16 'Stallion' was designed by OKB-8, now Novator NPO, Yekaterinburg.

SS-N-18 'Stingray' (RSM-50/R-29R/3M40 Volna)

Type
Inter-continental-range, submarine-launched, liquid-propellant, Multiple Independently targetable Re-entry Vehicle (MIRV)-capable ballistic missile.

Development
The SS-N-18 has the Russian designation RSM-50 (or R-29R/3M40) and is called Volna. The SS-N-18 began development in 1968 and was first tested from land-based launch sites in 1975 and from a submarine in November 1976, shortly after the first tests of the SS-N-17. There were long-range tests into the Pacific in late 1978. There were three versions of SS-N-18 developed, the Mod 1 has three MIRVs, Mod 2 has a single warhead and Mod 3 has seven MIRVs.

The missile has many similarities with the SS-N-8, from which it may have been derived; it does, however, have a more sophisticated guidance system and a MIRV warhead dispensing system. The complete system was designated the D-9R complex. The SS-N-18 missile is deployed in 'Delta 3' class submarines, with the Russian name 'Kalmar' or type 667BDR. Each boat carries 16 missiles. The Russians announced in 1991 that all SS-N-18 missiles had been downloaded to the Mod 1 version, with three Re-entry Vehicles (RVs) in MIRV configuration.

Specifications

	SS-N-18 Mod 1	SS-N-18 Mod 2	SS-N-18 Mod 3
Length	14.6 m	14.6 m	14.6 m
Body diameter	1.8 m	1.8 m	1.8 m
Launch weight	35,300 kg	35,300 kg	35,300 kg
Payload	3 × MIRV	Single warhead	7 × MIRV
Warhead	Nuclear 500 kT	Nuclear 450 kT	Nuclear 100 kT
Guidance	Inertial with stellar Update	Inertial with stellar update	Inertial with stellar update
Propulsion	2-stage liquid	2-stage liquid	2-stage liquid
Range	6,500 km	8,000 km	6,500 km
Accuracy	900 m CEP	900 m CEP	900 m CEP

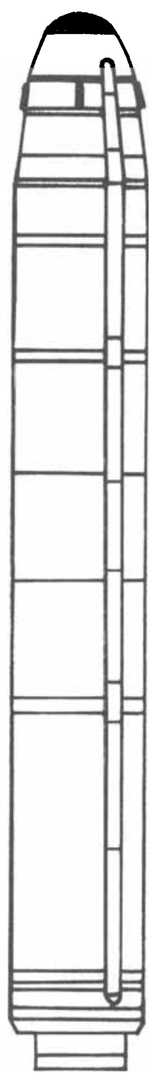
Description
The SS-N-18 is a two-stage, liquid-propellant, inter-continental-range, ballistic missile, 14.6 m in length and with a diameter of 1.8 m. It has a launch weight of 35,300 kg. The maximum range is 6,500 km for the MIRV variants and 8,000 km for the single RV version. The minimum range for all three versions is believed to be 2,000 km. The Mod 1 carries a payload of three 500 kT RVs in MIRV configuration; the Mod 2 a single RV with a yield of 450 kT, and the Mod 3 up to seven RVs with a yield of 100 kT each in an MIRV configuration. The provisional Strategic Arms Reduction Treaty (START) agreement allocated seven RVs to the SS-N-18 missile, but the Russians downloaded all missiles to three RVs. The SS-N-18 has a declared throw weight of 1,650 kg. Guidance is inertial with stellar updates, with an improved system developed from that used on SS-N-8. The accuracy of the SS-N-18 is around 900 m CEP.

Operational status
The SS-N-18 Mod 1 first entered service in 1977; the Mod 2 and Mod 3 in 1978. By 1983, there were 14 'Delta 3' boats, each with 16 launch tubes carrying the missile and there were still 14 boats in service in 1991. There was a total of 224 missiles operational in 1991 and a further 100 missiles in storage. The 'Delta 3' boats were based at Yagelnaya (three boats), Olenya (two) and Rybachiy (nine). Spare missiles were stored at the operational bases, at Pavlovskoye, Okolnya and Revna. A single SS-N-18 missile was at the Pasino conversion/elimination facility. Following the START 1 and 2 agreements it was expected that some SS-N-18 missiles would be removed from service during the 1990s. by December 1994, the number of operational missiles had reduced to 208 with 13 'Delta 3' submarines, and this was still the position in July 1997. By January 1999 it was estimated that only nine 'Delta 3' boats remained in service, six in the Pacific at Rybachiy and three in the Northern Fleet at Saida Guba.

In April 1999 it was reported that Russia had decided to retain eight 'Delta 3' boats, and that there were around 140 to 180 missiles available, but by June 2002 there were only six boats remaining operational. It is expected that four boats will remain in the Pacific Fleet, with two in the Northern Fleet, and that the number of missiles will reduce to 70 by the end of 2002. It is reported that there had been 146 test flights of SS-N-18 missiles up to July 2001,

The SS-N-18 was proposed for use as a satellite launch vehicle, to be called 'Volyna', launched from a converted 'Delta 3' submarine, with the capability to place a 130 kg payload into a 250 km circular orbit, with a trial launch carried out in June 1995. A second launch was made in July 2001, but this was unsuccessful. A third launch was made in July 2002, when an inflatable re-entry and descent technology experiment was completed.

Contractor
The SS-N-18 was designed by the Makeyev Design Bureau.



A diagram of the SS-N-18 missile 0038266

A 'Delta 3' class submarine. which carries 16 SS-N-18 'Stingray' missiles 0003145

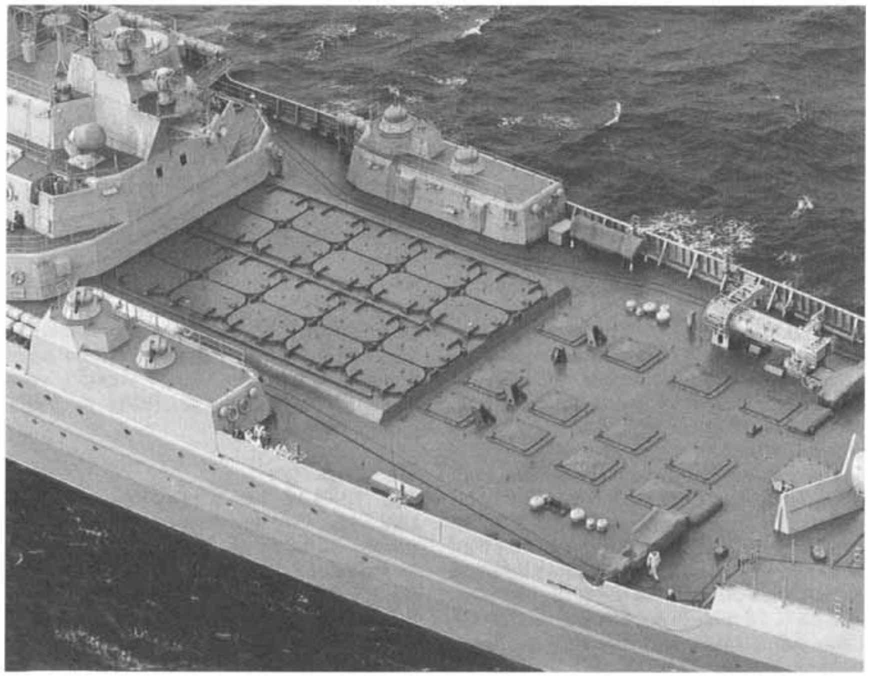
SS-N-19 'Shipwreck' (P-500/-700 Granite, 3M45)

Type

Intermediate-range, ship- and submarine-launched, turbofan-powered, single-warhead surface-to-surface missile.

Development

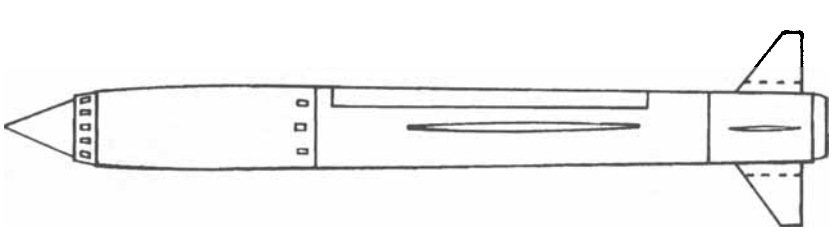
This third-generation anti-ship missile, SS-N-19 'Shipwreck, followed on the progressive development of the SS-N-3 'Shaddock'/'Sepal' and SS-N-12 'Sandbox' systems. Development started in 1969, and SS-N-19 was the first vertically-launched Russian ship- or submarine-launched cruise missile. The first flight test was made in 1975, and operational evaluation trials were held from 1979 to 1983. Flight tests were made from coastal launchers, submarines and a 'Kirov' class cruiser. The missile has the Russian designators P-500 and 3M45, and a later version has the designator P-700. A report in 2002 stated that upgrades were being developed to keep these missiles in service until 2020. The weapon system has the name Granite (although Granite is also the Russian name for the 'Oscar 1' class submarine). The weapon system includes the missile, launch system, radar, ESM sensors, and satellite datalinks. SS-N-19 'shipwreck' missiles are carried in the 'Kirov' class (project 1144) battle cruisers with 20 launchers, 'Oscar 1/2' class (project 949) submarines with 24 missiles and one 'Kuznetsov' class (project 1143.5) aircraft carrier with 12 launchers.



The Russian battle cruiser Admiral Ushakov, *photographed in 1980, showing the 20 hatches on top of the vertical launch tubes for SS-N- 79 'Shipwreck missiles, with the smaller 72 hatches on the right of the picture for the SA-N-6 'Grumble'*

Description

The SS-N-19 missile is different to the earlier SS-N-3 and SS-N-12 missiles in that the turbojet engine air inlet is in the nose, with the radar seeker assembly forming part of the inlet. The missile has two delta wings at mid-body, that extend to a span of 2.6 m after launch. There are aircraft type tail and fin surfaces at the rear of the body. SS-N-19 is 10.0 m long, with a body diameter of 0.85 m, and a launch weight of 6,980 kg. Mid-course guidance is inertial, with command updates provided by a 'Front Door C' radar, from an aircraft or helicopter, or from a satellite datalink via the launch ship. The 'Front Door C' engagement radar operates in S-band (3 to 4 GHz) and has a rectangular mesh antenna with a horn feed at the top. It has also been reported that Radar Ocean Surveillance Satellites (RORSAT) are used to locate large ship targets for SS-N-19 'Shipwreck missiles, although it is believed that this data would be passed to the ship for onward command updates to the missiles. The 'Kirov' class battle cruisers carry Ka-25 'Hormone' helicopters, and it has been suggested that these might be capable for use with SS-N-19 'Shipwreck' missiles. The Granite weapon control system takes input target data from satellites, ships, aircraft and ECM receivers and provides the target data for the missiles and updates during flight. The weapon system controls salvo firing, and allocates missiles to specific ship targets if the targets are in a group. The lead missile in a salvo detects the target group, communicates back to the launch ship, and the ship designates particular targets to each missile in the salvo. An active radar terminal guidance system is fitted to the missile, and this has two operating frequencies. At high level the radar operates in S-band (3 GHz) to search for the target ship, and then switches off while the missile descends to low level for the terminal phase. The radar then switches to its X-band (8 to 10 GHz) mode to locate the target for the final phase. The two radar modes have passive as well as active seeker elements. There are reported to be algorithms in the seeker to analyse the target ship transmissions and determine when the missile should take evasive manoeuvres. An unconfirmed report suggested that there was also an infra-red option as an interchangeable terminal seeker. A solid propellant boost motor, located within the aft section of the jet pipe, is jettisoned after use, and provides the vertical launch capability for the missile. The missile is stored in its canister with a protective nosecone and tail cone, as the launch assembly is flooded with water before launch. For submarine launches the missile canisters are mounted each side of the sail, inclined at 47°, and the nosecone remains on the missile until it broaches the water. For ships the SM-233 launch assemblies are mounted vertically, and the nosecone is ejected shortly after launch. Following launch, a TRDKP-93 turbojet engine powers the missile for the mid-course and terminal phases. The SS-N-19 is reported to have a high-altitude cruise, in excess of 65,000 ft (20 km) at M2.5, followed by a steep dive onto the target. The minimum range is 20 km, and the maximum range is 550 km. A longer range can be obtained if a smaller warhead is fitted, extending the range to 625 km. An alternative low-level cruise profile can be flown at around 10 m altitude, with a range of 200 km. The missile can cruise at high altitude and then descend to low level for the terminal phase, when the speed is around M1.5. The missile is reported to have a 750 kg payload that could be nuclear (500 kT) or conventional High Explosive (HE). In addition, it is believed that Russia could have developed a fuel-air explosive warhead, thought to be particularly effective against ship targets.



A line diagram of an SS-N-19 missile ***NEW***/0525199

Operational status

SS-N-19 'Shipwreck missiles entered service in 1983, and it is thought that there were about 265 to 325 missiles in service in 1991 carried on eight 'Oscar 1/2' submarines, one 'Kuznetsov' class aircraft

carrier and three 'Kirov' class battle cruisers. The missile numbers are believed to have remained constant to the end of 1995, but by June 2002 there were six 'Oscar 2' boats, one 'Kuznetsov' aircraft carrier and two 'Kirov' battle cruisers in service, and the missile numbers had probably reduced to around 300. The 'Oscar 2' boats carry 22 live warhead missiles, and two training missiles. It is reported that these missiles will probably remain in service until 2010, and could have a further life extension to 2020.

Specifications

Length: 10.0 m
Body diameter: 0.85 m
Launch weight: 6,980 kg
Payload: Single warhead; 750 kg
Warhead: Nuclear 500 kT or conventional HE
Guidance: Inertial with command update and active radar/IR
Propulsion: Solid boost and turbojet
Range: 550 km
Accuracy: n/k

Associated radars
Engagement radar: 'Front Door C'
Frequency: 3-4 GHz (S-band)
Range: 55 km

Contractor

It is believed that the **SS-N-19** 'Shipwreck' missile system was designed by the Chelomei design bureau, but is now supported by **KBM,** Kolomna.

SS-N-20 'Sturgeon' (RSM-52/R-39/3M65)

Type
Inter-continental-range, submarine-launched, solid-propellant, Multiple Independently targetable Re-entry Vehicle (MIRV)-capable ballistic missile.

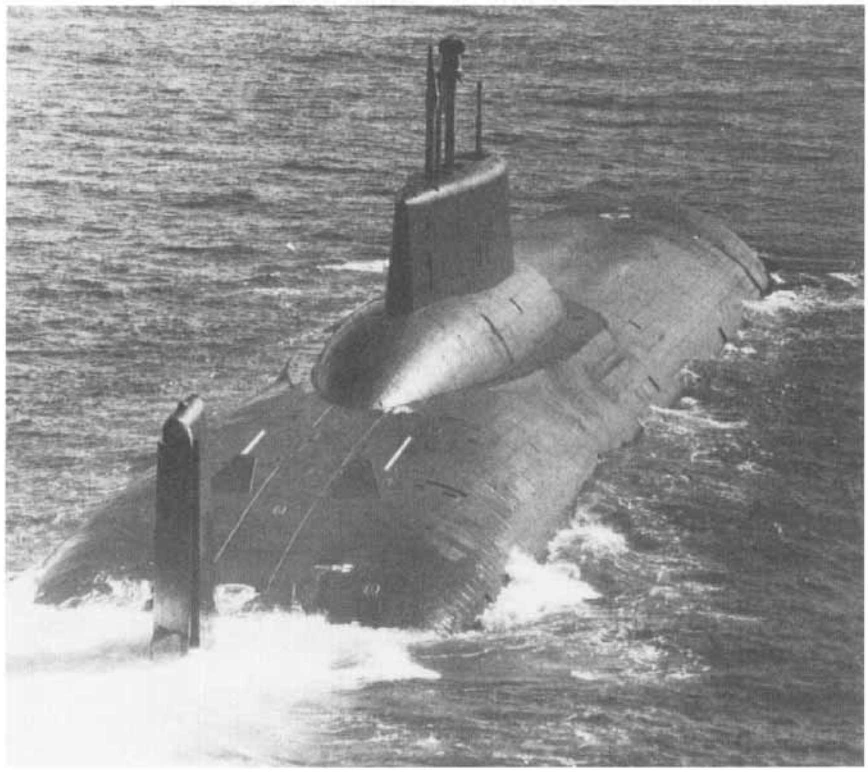
Development
The SS-N-20 has the Russian designation RSM-52 and has the missile designators 3M65 or R-39 Taifun. The SS-N-20 began development in 1972 with the first flight tests taking place in January 1980. There was a long run of failures of this second attempt at solid-propellant Submarine-Launched Ballistic Missiles (SLBMs), but two successful tests were reported in 1981 and, in October 1982, a simultaneous launch of four missiles was reported. It is believed that there were around 30 trials launches during the development and evaluation programme. The complete submarine weapon system is known as the D-19 complex.

The missile is carried in the 'Typhoon', a 25,000-tonne (project 941) submarine with 20 launch tubes located forward of the boat's sail; the first Nuclear-Powered Ballistic Missile Submarine (SSBN) to exhibit this feature. The first of these boats was launched in September 1980, and there were six 'Typhoon' class boats operational in 1991.

Reports in 1992 indicated that a follow-on successor to SS-N-20 was being developed, and had been allocated the NATO designator SS-NX-28. It is believed that this new missile was to have been made entirely in the Russian Federation, but there are reported to have been development problems and the SS-NX-28 programme has been terminated.

In 2001 it was reported that Russia was modifying the SS-27 Topol-M ICBM design to create a new SLBM, with the designator SS-NX-30.

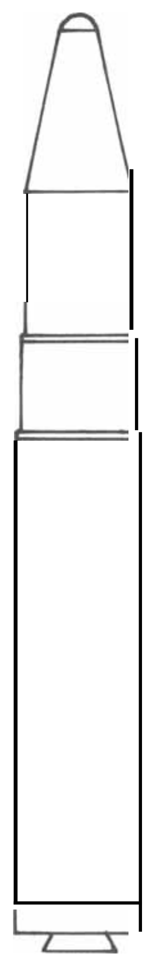
Description
The SS-N-20 is a submarine-launched, three-stage, solid-propellant, MIRV-capable, inter-continental range ballistic missile, 16.1 m long and 2.4 m in diameter for the first stage and 2.3 m diameter for the second stage. The third-stage engine is mounted inside the post-boost bus that carries the re-entry vehicles. The first stage has a length of 9.5 m, a weight of 52,800 kg and has a single solid-propellant 3D65 motor. The SS-N-20 has a launch weight of 87,600 kg. The missile is believed to have a minimum range of 2,000 km, and a maximum range of 8,300 km. The missile carries a payload of 10 Re-entry Vehicles (RVs) in a MIRV configuration, each nuclear warhead with a yield of 200 kT, and with a throw weight of 2,550 kg. US reports suggest that an earlier (modification 1) payload design had six RVs, but this was not confirmed in the Strategic Arms Reduction Treaty 1 (START 1) data released by Russia in 1991. Guidance is inertial with stellar updates, and an accuracy of 500 m CEP has been reported. The SS-N-20 missiles are cold launched from their canisters, by a 6,000 kg ring structure around the nose of the missile, that is jettisoned after the missile has broached the water surface. The solid propellant gas efflux provides an envelope around the missile as it travels through the water. The missiles can be launched at 15 second intervals.



A 'Typhoon' class submarine, platform for the SS-N-20 'Sturgeon

Operational status
The SS-N-20 entered service in 1983 and in 1991 was deployed in six 'Typhoon' class boats, with 120 missiles in service. A further 31 missiles were located at Nenoska, where the SS-N-20 is tested. All six 'Typhoon' boats were based at Nerpichya in Russia. In July 1995, it was confirmed that 120 missiles remain operational, but there were only 10 missiles in storage, and it is assumed that 20 missiles had been fired in the four-year period from 1991. A trials firing of an SS-N-20 was made in September 1995, with the launch submarine at the North Pole, and a missile range of 2,500 km. In February 1997, a full boat load of 20 missiles was fired, and in October 1999 two further missiles were launched.

In June 2002 it was estimated that around 60 missiles remained operational or in storage. Three 'Typhoon' boats were operational with the Northern Fleet in 2002 at Litsa Guba, and it is expected that these will remain in service until 2010. One of these boats, TK 208, completed a 10 year refit in 2002, and is expected to be the trials platform for the SS-NX-30 Bulava missile, being developed from the SS-27 Topol-M. China was reported to have been interested in buying two modernised 'Typhoon' boats with SS-N-20 missiles, but no order has yet been confirmed. The Russians were proposing to download



A diagram of the SS-N-20 missile

SS-N-20 missiles to six or four RV under the START 2 agreements. However, following the scrapping of START 2 it now seems more likely that the SS-N-20 missiles will remain with 10 MIRV each.

A proposal was made in 1993 to modify an SS-N-20 missile first stage to carry the three stages of an SS-N-23 'Skiff' to make up a civil satellite launcher to be known as Surf with a 2,000 kg payload capability in low Earth orbit. A trial launch of Surf from a vertical floating launch barge was planned for 1994 but has been delayed, and the project may have been terminated.

Specifications

Length: 16.1 m
Body diameter: 1st-stage 2.4 m; 2nd-stage 2.3 m
Launch weight: 87,600 kg
Payload: 10 RVs in MIRV configuration
Warhead: 200 kT nuclear each
Guidance: Inertial plus stellar reference update
Propulsion: 3-stage solid
Range: 8,300 km
Accuracy: 500 m CEP

Contractor

The SS-N-20 was designed by the Makeyev Design Bureau.

SS-N-21 'Sampson' (RK-55 Granat/3M10)

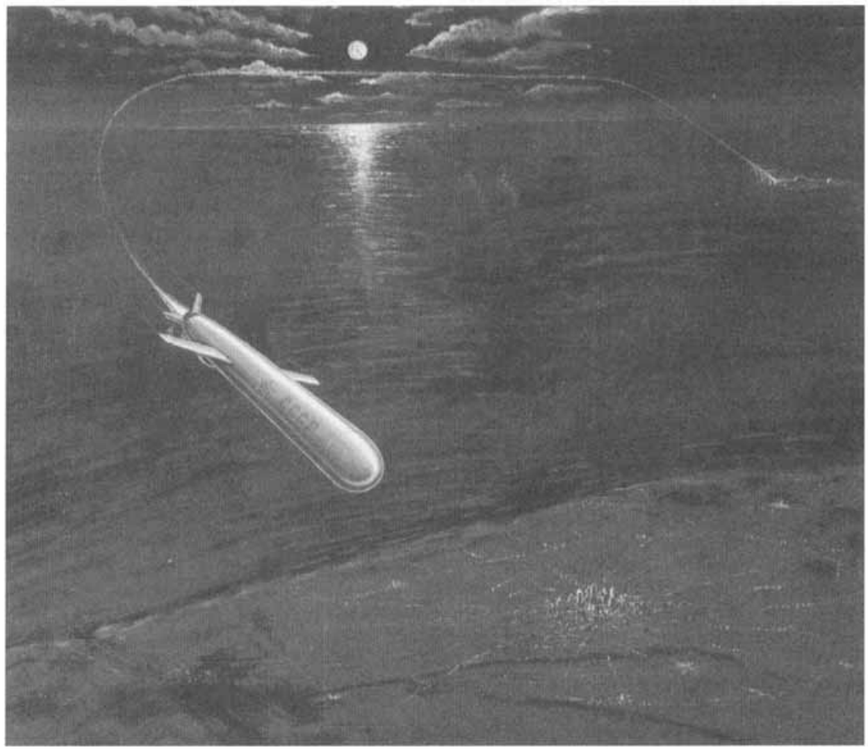
Type

Intermediate-range, submarine-launched, turbofan-powered, single-warhead surface-to-surface missile.

Development

The Russians started the development of a family of cruise missiles from 1976; air-launched, AS-15 'Kent', ground-launched SSC-X-4, and submarine-launched SS-N-21 'Sampson'. The three variants are similar in shape, and it is believed that SS-N-21 has the Russian designator RK-55 (3M10) and the name Granat. It is believed that SS-N-21 was test flown from 1982, and became operational in 1984. It is reported that SS-N-21 can be carried in 'Victor 3' (project 671RTM), 'Akula 1/2' (project 971). 'Sierra 1/2' (project 945) and 'Yankee Notch' (project 667AR/AT) class submarines. The missiles are launched through 533 mm torpedo tubes, and each boat can carry between 20 and 35 missiles, although the actual numbers are believed to be much less. There were suggestions that SS-N-21 could be fitted to converted 'Delta 1/2/3' submarines in the future, or fitted to surface ships, but none have been confirmed. The SSC-X-4 variant was destroyed as part of the 1987 INF Treaty agreements.

It is believed that a conventional High Explosive (HE) warhead and submunition warhead versions of SS-N-21 may have been developed. In 1993, Novator exhibited a two-stage missile, designated SS-NX-27 by NATO and 3M14/3M54 in Russia, based on the SS-N-21 design (see separate entry). In 1997, US Navy reports suggested that SS-N-21, presumably conventional HE warhead or submunition versions, were being designed into the new Russian 'Yasen' class (Type 885) submarines for launch from both vertical weapons bays and torpedo tubes, although it is now believed that the SS-NX-27 will be fitted instead.



An artist's impression of the SS-N-21 'Sampson submarine-launched cruise missile

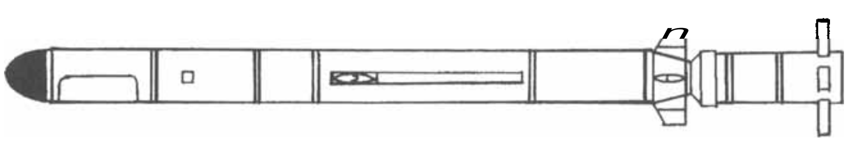
Description

Little detail has been made available about SS-N-21, but it can be assumed to be similar to SSC-X-4, and some details about this latter missile were released at the time of the exchange of data with the Intermediate-range Nuclear Forces (INF) Treaty in 1987. The missile is 8.09 m long, has a body diameter of 0.51 m and a wingspan of 3.3 m. The launch weight is 1,700 kg, and a single 200 kT nuclear or a 410 kg conventional HE or submunitions warhead is fitted. Guidance is inertial for mid-course with some form of active radar terrain matching for updates and terminal guidance. The missile has a radar altimeter and flies at low level, probably around 200 m. It is believed that the missile has an accuracy of 150 m Circular Error of Probability (CEP). The missile is launched from a standard 533 mm diameter torpedo tube, the wings unfold and the turbofan engine is started on leaving the water. The air inlet for the turbofan engine is a scoop shape, and is located below the rear body. This is different to the air-launched AS-15 missile, where the engine drops down below the rear body on a pylon. The missile has an expendable solid-propellant booster mounted in tandem at the rear, and this is jettisoned after launch. The missile has a cruise speed of M0.7, and SS-N-21 is reported to have a maximum range of 2,400 km.

Operational status

The SS-N-21 is reported to have entered service with the Russian Navy in 1984. The Russians reported that 240 missiles were deployed in service in 1991, carried in 37 submarines. In 1992, Russia indicated that SS-N-21 would be removed from operational service as part of the Strategic Arms Reduction Treaty 2 (START 2) agreement, and production terminated. However, following the extensive use of US RGM/UGM-109 Tomahawk cruise missiles against land targets, with HE and submunition warheads, it is possible that some SS-N-21s may have been modified with HE or submunition warheads.

In 2002, there were approximately 17 Russian submarines capable of carrying SS-N-21 missiles in operational service, including 'Victor 3'. 'Akula 1/2', 'Sierra 2' and 'Yankee Notch' class boats. The number of missiles remaining in service are difficult to estimate, but are thought to be around 200.



A line diagram of the SS-N-21 'Sampson' missile NEW/0116336

Specifications

Length: 8.09 m
Body diameter: 0.51 m
Launch weight: 1,700 kg
Payload: Single warhead
Warhead: Nuclear 200 kT or 410 kg HE
Guidance: Inertial and terrain matching
Propulsion: Turbofan with solid booster
Range: 2,400 km
Accuracy: 150 m CEP

Contractor

It is believed that the SS-N-21 'Sampson' missile was designed by the Raduga NPO, although other reports suggest the Novator NPO.

SS-N-22 'Sunburn' (P-80/-270/3M-80/3M82 Zubr/ Moskit)

Type

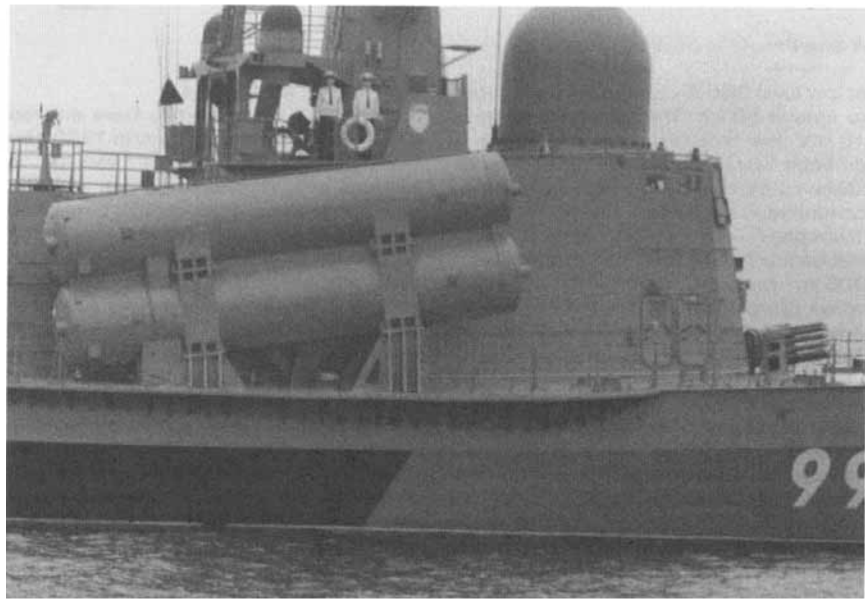
Short-range, ground-, air- and ship-launched, ramjet-powered, single-warhead, surface-to-surface missile.

Development

The SS-N-22 'Sunburn' was the NATO designation assigned to large anti-ship cruise missiles, housed in launchers aboard the Russian 'Sovremenny' (project 956) class destroyers and 'Tarantul 3' (project 1241) class corvettes that made their appearance in 1981. The missile is believed to have been designed to be supersonic specifically to defeat US Navy Aegis/Standard RIM-67 equipped cruisers and destroyers. The original SS-N-22 missile is believed to have the Russian designators P-80, 3M80 and was called Zubr. An improved version has the designators P-270. 3M82 and is called Moskit. This second version has also been offered for export as the Kh-41 air-to-surface missile, and is covered in a separate entry. Because these ships are also fitted with the 'Band Stand' engagement radar, which is part of the SS-N-9 system carried on other Russian ships, it is believed that SS-N-22 'Sunburn' was developed to replace SS-N-9 'Siren', and that development probably started in the early 1970s. A 3M-80E missile was offered for export in 1993, with a range increased to 120 km, and it is believed that this version was already in service in Russia.

The improved P-270 version, with a range of 160 km, was reported to have been designed and offered for export in 1992. This version may have been designed to take a 200 kT nuclear warhead. In 1995, a ground-launched coastal defence version was announced, using the 3M-80E missile with two or three missiles per launch vehicle. In 1998, a low-cost improvement was proposed for SS-N-22, to increase the range to 150 km, with a further range increase to 200 km proposed by adding a ventral tank to hold additional fuel. In 2001, a report stated that a joint Chinese/Russian programme was developing an improved SS-N-22 missile system, possibly with the name Rizhi, for fitment on the Chinese 'Sovremenny' class destroyers. The USA has evaluated the SS-N-22 missile for conversion to an anti-ship missile target, but by June 2001 there had been no contract placed.

There are eight SS-N-22 'Sunburn' launcher canisters grouped in fours fitted to the 'Sovremenny' (project 956) and 'Udaloy 2' (project 1155.1) destroyers, four grouped in pairs on the 'Tarantul 3' class (project 1241.1) missile corvettes and eight launchers on the 'Dergach' class (project 1239) fast attack craft air cushion vessel. A prototype wing-in-ground-effect project 905 'Utka' flying boat trialled SS-N-22 missiles in 1992, but this project was terminated. The project 12421 corvettes updating 'Tarantul 3' ships, are planned to carry four improved SS-N-22 missiles (3M82 version).

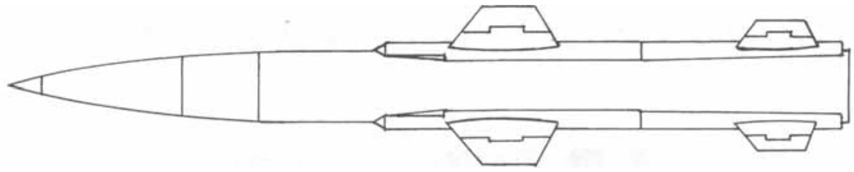


A close-up view of a pair of SS-N-22 missile canisters on a Russian 'Tarantul 3' missile corvette. showing the 'Band Stand' engagement radar just above and forward of the canisters

Description

The SS-N-22 'Sunburn' (3M-80) is 9.39 m long, has a body diameter of 0.76 m and with wings and fins folded in its canister has a diameter of 1.3 m. The wingspan is 2.1 m, unfolded. The missile has a launch weight of 3,950 kg. Guidance is inertial in mid-course with command updates, with a dual mode active/passive radar terminal seeker. Unconfirmed reports suggest that the missile can downlink terminal seeker data to the launch ship, to enable the launch ship to select particular targets in a group. SS-N-22 can be launched from its canister and then make a 60° turn towards the target. The missile is controlled by four moving fins, located at the rear of the body section. The 'Band Stand' S-band (Russian names Monolit or Mineral) engagement radar (2 to 4 GHz) tracks the missile and command data is sent to the missile by a 'Light Bulb' antenna A large radome houses the 'Band Stand' antenna, this is located just forward and above the KT-190 launch canisters on both the 'Sovremenny' and 'Tarantul 3' ships The 3Ts-80 fire-control system associated with SS-N-22 has the Russian name Sapfir, and this can track up to 15 targets. The maximum range of the SS-N-22 is 90 km, but this can only be achieved with a high-level cruise, and if the missile is programmed to fly all the way

A Russian Sovremenny' class destroyer with quadruple SS-N-22 'Sunburn' missile canisters below the bridge on the port side



A diagram of the SS-N-22 'Sunburn' missile

at low level then the range will be reduced to around 50 km. The minimum range is 10 km. The maximum unaided range is probably 50 km, and longer ranges will be achieved by over-the-horizon targeting or command updates using Ka-25 'Hormone-B' or Ka-27 'Helix-B' anti-submarine helicopters. The missile has a 300 kg warhead, which can be either conventional High Explosive (HE) Semi-Armour Piercing (SAP) or 200 kT nuclear. The 'Sunburn' missile has an integral solid-propellant boost motor within the combustion chamber of the ramjet, and can cruise at high or low level. At high level, believed to be around 10 km altitude, the missile has a cruise speed of M 2.5. The missile has a cruise speed of M2.1 at low level with cruise altitudes in the terminal phase of between 7 and 20 m. It is reported that the missile can make evasive manoeuvres during the terminal phase, to avoid defending missile and gun systems. The ramjet motor was developed by the Soyuz MKB. The SS-N-22 is reported to have an 18 month period in its canister before routine maintenance checks are required.

The improved 3M82 (P-270) version has a length of 9.74 m, a weight of 4,500 kg, and a range increased to 160 km. It is believed that this version has an improved HE SAP warhead with a weight of 320 kg. The launch canister for this version is designated KT-152ME.

Operational status

The SS-N-22 is believed to have entered service with the Russian Navy in 1980. The improved 3M82 (P-270) version is believed to have entered service in 1993, and may still be in production. It is reported that some SS-N-22s have been transferred to the Ukraine, and that some missiles were sold on to Iran in 1993 for use as coastal defence weapons. This has been denied by Ukraine, and perhaps the missiles were SS-N-2 'Styx'. There was a report that SS-N-22 missiles had been ordered by India, and that the system called 'Koral' by India would be fitted to Indian Project 15 ('Delhi' class) destroyers, but SS-N-25 missiles have been fitted to these ships. In 1997, it was announced that two new build 'Sovremenny' class destroyers and 50 SS-N-22 missiles had been ordered by China.

Two further 'Sovremenny' class ships were planned to be ordered by China in 2000, to be refurbished from Russian Navy ships, but this order has not been confirmed. The first new build 'Sovremenny' was delivered to China in January 2000, and the first missiles were delivered to China in April 2000. SS-N-22 trials firings have been reported from China with two missiles launched in August 2000, two in November 2000, and one in February 2001. In addition, proposals have been made to fit SS-N-22 missiles to Chinese 'Lula' and 'Luhu' class destroyers and 'Jianghu' frigates. In 1999 it was reported that the US Navy was negotiating to buy 150 missiles for conversion into targets, to use against the RIM-67 Standard missile ship defence system. It is thought that around 450 missiles were in service in Russia in 1996, carried by 18 'Sovremenny' destroyers, one 'Udaloy 2' destroyer, 29 'Tarantul 3' corvettes and on two 'Dergach' FAC-ACV.

By June 2002 the numbers had been reduced to four 'Sovremenny' and one 'Udaloy 2' destroyers, 21 'Tarantul 3' corvettes and two 'Dergach' FAC-ACV, with probably 220 missiles in service or in store.

Specifications

Length: 9.39 m (3M80), 9.74 m (3M82)
Body diameter: 0.76 m
Launch weight: 3,950 kg (3M80) 4,500 kg (3M82)
Payload: Single warhead; 300 or 320 kg
Warheads: Conventional HE or nuclear 200 kT
Guidance: Inertial with updates and active/passive radar
Propulsion: Solid propellant and ramjet
Range: 90 km (3M80), 160 km (3M82)
Accuracy: n/k
Associated radars
Surveillance radars: 'Top Steer', 'Top Plate', 'Plate Steer'
Frequency: 2-3 GHz (S-band)
Range: n/k
Engagement radar: 'Band Stand'
Frequency: 2-4 GHz (S-band)
Range: 55 km

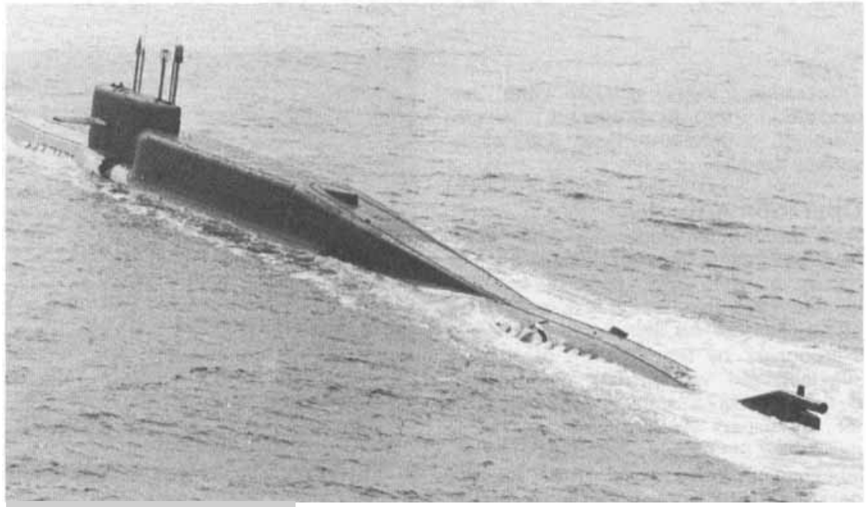
Contractor

SS-N-22 was designed by the Raduga NPO (missile) and Altair NPO (ship systems).

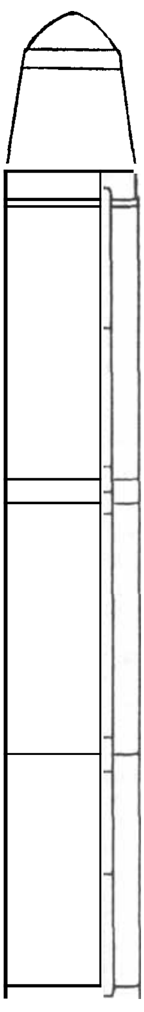
SS-N-23 'Skiff' (RSM-54/R-29RM/3M27 Shetal)

Type
Inter-continental-range, submarine-launched, liquid-propellant, Multiple Independently targetable Re-entry Vehicle (MIRV)-capable ballistic missile.

Development
The SS-N-23 'Skiff' has the Russian designators RSM-54 (or R-29RM/3M27) and name Shetal or Shtil. It was the successor to the SS-N-18, an indication that the Russians continued to use liquid-propelled missiles, perhaps on grounds of extensive experience and confidence in their safety, perhaps through disappointment with the solid-propelled SS-N-17 and 20. The SS-N-23 began testing in 1983 and is now at sea in the 'Delta 4' class (project 667 BDRM) submarines, with 16 launch tubes. These submarines are a variant of the 'Delta 3' with the Russian name Delphin. The SS-N-23 missile system is known as the D-9RM. The missile was initially tested with 10 MIRV, and later with four MIRV, but in 1991, the Russians stated that only the four MIRV versions were in service. A more accurate version was tested in 1988, and entered service in 1989. A life extension programme was started in 1998, and it is reported that limited production was re-started in 1999, possibly for a modified version known as Sinerva with 10 MIRV.



A 'Delta4' submarine, the platform for the SS-N-23 'Skiff SLBM



A line diagram of the *SS-N-23* missile

Due to development problems with the SS-NX-28 missile, it has been reported that SS-N-23 missiles will be fitted to the new 'Borey' class (type 955) SSBN as an interim measure, pending the development of a suitable successor.

Description
The SS-N-23 is a submarine-launched, three-stage liquid-propelled, MIRV-capable, ballistic missile, 14.8 m long, with a body diameter of 1.9 m for the first stage and 1.85 m for the second stage. The first stage motors are RD-0243/0244/0245, but the designators for the second- and third-stage motors are not known. The payload motors and the third stage motors are integrated. SS-N-23 has a launch weight of 40,300 kg. It is believed that the minimum range is 2,000 km, and the maximum range 8,300 km. The accuracy was 900 m CEP for the initial version, but the improved version is estimated at 500 m CEP. The missile has a stellar/inertial guidance system, which is used for in-flight position correction together with a satellite radio-command link. The SS-N-23 carries four MIRV warheads each with a nuclear warhead rated at 100 kT, and has a throw weight of 2,800 kg. It is believed that decoys are fitted to this missile. It is reported that the 'Delta 4' boats can launch SS-N-23 missiles from depths down to 55 m at a speed of up to 5 kt.

Operational status
The SS-N-23 entered operational service in 1986 and 112 missiles were deployed in seven 'Delta 4' boats in 1991. All seven boats were based at Olenya in Russia, but a further 50 missiles were in storage at Okolnya and Revna. Some SS-N-23s were originally expected to be retrofitted into 'Delta 3s' to replace SS-N-18s but there is no confirmation that this has occurred. 112 missiles were still operational in July 1996. A test launch was conducted from the Barents Sea in July 1996, and two missiles were launched in February 1998. Further tests have been reported in March, September and December 2000, and in February and June 2001.

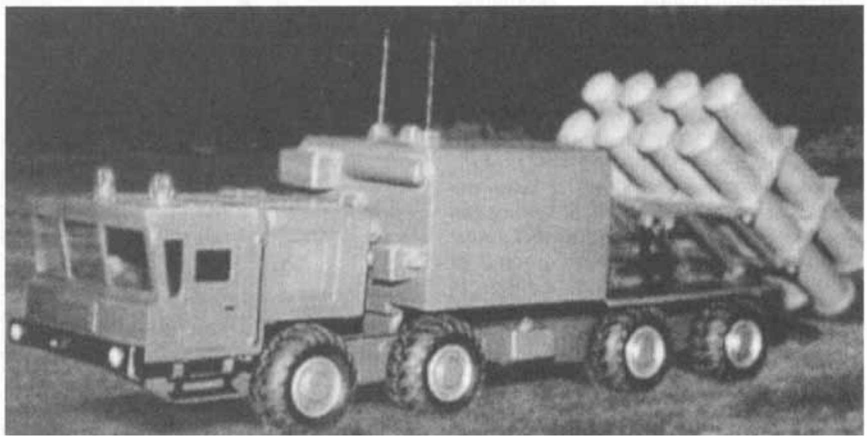
By June 2002, there were seven 'Delta 4' boats available, although two were in refit. The boats are with the Northern Fleet, based at Saida Guba, with around 95 operational missiles. It is believed that the reserve missiles had reduced to 30. It was reported in October 1999 that production of the SS-N-23 missiles had been re-started, following the termination of the SS-NX-28 programme, but this may refer to limited assemblies to extend the life of the existing missiles.

SS-N-23 missiles have been proposed for use as satellite launch vehicles, from converted 'Delta 3' submarines or floating barge launchers. with the capability to place a 550 kg payload into an 800 km circular orbit or 2,000 kg into low Earth orbit. The modified SS-N-23 missile-based SLV would be known as Surf, and is believed to comprise the first stage of the SS-N-20 'Sturgeon' with the three stages of SS-N-23, and was being marketed together with modified SS-N-8 and SS-N-18 liquid propellant SLBMs as space vehicle launchers. In July 1998 a Shtil-1 satellite launch vehicle was launched from a 'Delta 4' boat from under the sea just north of Murmansk, a world first. The launch vehicle was a modified SS-N-23, carrying two small German research satellites into low earth orbit.

Specifications
Length: 14.8 m
Body diameter: 1.9 m
Launch weight: 40,300 kg
Payload: 4 RVs in MIRV configuration
Warhead: 100 kT nuclear each
Guidance: Inertial plus stellar reference update. Computer-controlled PBV
Propulsion: 3-stage liquid, plus PBV
Range: 8,300 km
Accuracy: 500 m CEP

Contractor
SS-N-23 was designed by the Makeyev Design Bureau, and built at the Makeyev State Rocket Centre, Miass.

SS-N-25 'Switchblade' (3M24 Uran)/AS-20 'Kayak' (Kh-35)/SSC-6 'Stooge' (3K60 Bal)

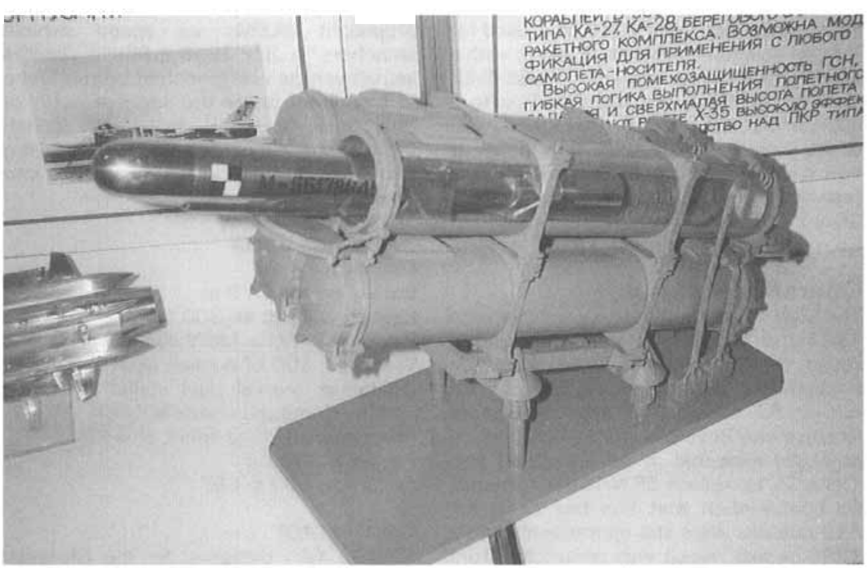


A model of an SSC-6 'Stooge' (Bal) TEL vehicle, with the eight launch Canisters raised to the launching position (Zvezda Strela) 0062333

Type
Short-range, ship-, ground- and air-launched, turbofan-propelled, single-warhead surface-to-surface and air-to-surface missiles.

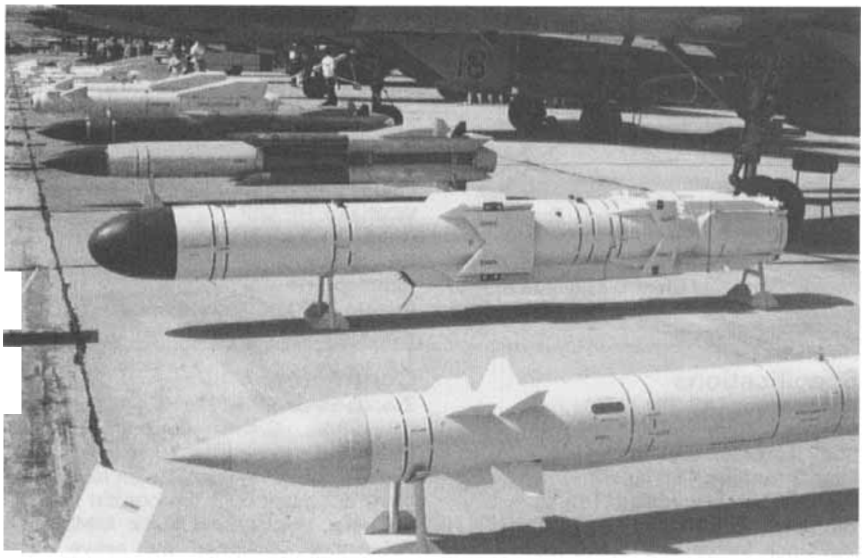
Development
Both the Russian Federation and NATO have given three different designators and names to this ship-, coastal- and air-launched anti-ship missile first seen at the 1992 Moscow Air Show and christened 'Harpoonski' by the Western press. The ship-launched version has the Russian designator 3M24 Uran (or 3M24E Uran-E for the export version), and the NATO designator SS-N-25 'Switchblade'. The air-launched version has the Russian designator Kh-35 (or X-35 for the export version) and the NATO designator AS-20 'Kayak. The coastal defence version is believed to have the Russian designator 3K60 Bal, and has been given the NATO designator SSC-6 'Stooge'. The SS-N-25, which closely resembles RGM-84 Harpoon, is reported to have been designed by the Zvezda-Strela OKB, which also designed the SS-N-9 'Siren' ship-launched missile. SS-N-25 was originally intended as a naval surface-to-surface missile for ship and coastal launch, and the air-launched version was added later. The new ,missile was also intended as an export replacement for the SS-N-2 'Styx' missiles, used widely around the world. Development of the ship-launched version began in 1983 and in 1989 there were reports of a former East German Navy missile boat being sighted with four Harpoon-sized canisters fitted. Development on an air-launched variant started in 1987 and a Kh-35 missile, less the tandem boost motor assembly of the ship- and ground-launched version, was exhibited in 1992. A ground-launched version was offered for export in 1993, with eight missiles in canisters mounted on a wheeled launcher vehicle. In addition, there was a wheeled radar, command and control vehicle and a reload transporter carrying a further eight missiles and a crane. The whole coastal defence system was called Bal, and designated 3K60. Further improvements were reported in 1992, including proposals for ship and coastal variants with increased ranges to 250 km, and these were being offered for export in 1997 as the 3M24E1 version. Also, there have been unconfirmed reports that studies are under way to look at firing SS-N-25 missiles enclosed in capsules from submerged submarines. In 1997, it was reported that an imaging IR seeker has been developed for a variant of the AS-20 air-launched version, with the Russian designator Kh-37, and it is expected that this variant will also be offered for export in ship- and ground-launched versions. In 1998 an improved AS-20 air-launched missile was reported to be in development, with a range of 250 to 300 km. It is believed that this version may be offered with INS/GPS guidance, for attacking land targets. It was also reported that a new helicopter-launched version would be developed.

The 'Nanuchka 4' (project 1234.2) trials missile corvette had two sextuple launchers of what appear to be SS-N-25 canisters and the missiles have also been reported on modified 'Krivak 1' (project 1135) frigates with eight missile canisters (2 × quadruple). The 'Neustrashimy' class (project 1154) frigates carry 16 missile canisters in four groups of four. Reports in 2002 stated that the modified 'Krivak 1' and 'Neutrashimy' ships have not had the missiles embarked. SS-N-25 missiles have been offered for export fitted to the Scorpion (project 12300) corvette and several classes of fast attack craft including modified 'Tarantul 3'. The air-launched AS-20 version has been cleared for use on the MiG-29K 'Fulcrum' carrier-borne aircraft, and can also be carried by the Su-24 'Fencer', Su-27 and Su-30 'Flanker', Tu-95 'Bear' and Tu-142M 'Bear F' aircraft and Kamov Ka-27, Ka-28 and Ka-50 naval helicopters. A modified version of the Kh-35 is also to be used as a Russian anti-ship missile target, to exercise ship defence systems against such threats as Exocet and Harpoon.



A model of a quadruple SS-N-25 canister launch installation for ship and coastal defence versions, shown in Moscow in 1992 (Christopher F Foss)

Description
The SS-N-25 is similar in appearance to the US RGM-84 Harpoon. The missile has four clipped-tip folding triangular wings at mid-body, and four smaller in-line clipped folding triangular moving control fins at the rear. There is an engine air inlet under the body just forward of the wings, and the large air duct runs between the wings all the way to the rear of the missile. The jettisonable tandem booster motor has four long slim rectangular stabilising fins, which are folded forward along the motor casing before launch. The missile, with its 0.42 m diameter booster motor, is 4.2 m long, has a body diameter of 0.42 m and, with a 145 kg HE SAP warhead, weighs 630 kg at launch. Guidance is inertial in mid-course with an active radar terminal seeker, the ARGS-35, which is a coherent radar operating in X band (8 to 20 GHz) with a lock-on range of 15 to 20 km.



The ship/coastal-launched SS-N-25 with wings and fins folded in a line up of air-to-surface missiles on display in Moscow in 1992 (Piotr Butowski)

The radar seeker has a weight of 40 kg, a length of 0.7 m, and scans in azimuth 45° either side of the boresight. The SS-N-25 is powered by a turbofan sustainer motor, and a tandem solid-propellant boost motor that is jettisoned after use. This combination is reported to give the missile a cruise speed of 290 m/s, a maximum range of 130 km, and a minimum of 5 km. From the released Russian documentation it would appear that the ship- and ground-launched versions are shipped, stored and launched from 3C34 containers. These containers are grouped in fours, at an angle of 35° on the 3C24 launcher assembly. It is believed that both the ship-based and ground-launched weapon systems have the same 3P60 fire-control system, developed by Granit Central Research Institute, using the Garpun-Bal 3T24 surveillance radar for surface search and target designation. This radar has both active and passive channels using the same rotating antenna on a time sharing basis. The active radar operates in X-band (8 to 10 GHz) while the passive radar covers the frequencies from 0.8 to 12 GHz. The 3P60 weapon control system can control up to six missiles at a time, with a salvo launched at 2 to 3 second intervals.

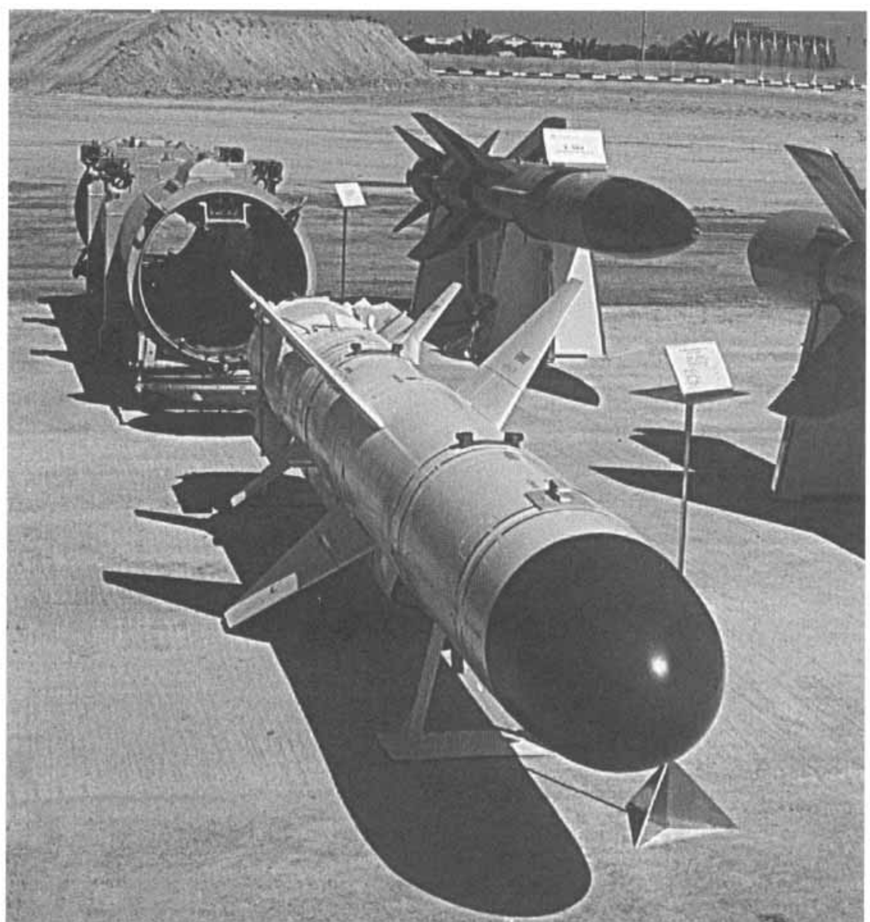
The AS-20 air-launched version is not fitted with the tandem booster and is reported to have the same 130 km range when launched from an altitude of 5,000 m. The AS-20 has a length of 3.75 m and a launch weight of 480 kg. All three versions of the SS-N-25 (AS-20 and SSC-6) are expected to fly the same flight pattern after booster or aircraft separation. The missile descends to a cruise altitude of 10 to 15 m, determined by its radio altimeter, and flies towards the target by inertial guidance under the power of its turbofan engine. At some point preset by the launch platform, the active radar seeker is selected into its search and acquire mode. When the seeker locks on to the target, the missile descends to an altitude of between 2 and 5 m for the terminal phase. An improved version is reported to fly at around 1 m in the terminal phase.

The mobile coastal defence system, 3K60 Bal, is reported to be based on an 8×8 truck that carries eight SSC-6 missiles in canisters, and is available in several combinations. For Russian use it is believed that the system has eight launchers, a command post vehicle, a command and control vehicle, a Typhoon 3T24 radar mounted on a target acquisition vehicle, eight reload vehicles fitted with hydraulic cranes, test and maintenance vehicles, and a helicopter for reconnaissance and target designation purposes. A single battery is described as having two command and control vehicles, four TEL, four reload vehicles, test and maintenance vehicles and 46 personnel. The TEL can travel at up to 60 km/hr on roads, takes 10 minutes to set-up and fire, and takes 30 minutes to reload.

An improved version of the SS-N-25 has been developed, and has the Russian designator 3M24M1 (or 3M24E1 for export). This version incorporates GPS (or Glonass) updates, carries more fuel and has a range increased to 250 km. The launch weight is increased to 700 kg, including the boost motor, and it is believed that this version is also longer than the standard version.

Operational status

SS-N-25 missile systems were believed to have entered service on a small number of modified 'Krivak 1' and 'Neustrashimy' class frigates in 1993. However, reports in 2002 suggested that the missiles have still not been fitted to these ships. The air-launched AS-20 variant is reported to have been flight tested in 1992 and to have entered service in 1995. The coastal defence SSC-6 missile system is believed to have been developed, and to have entered service in 1997. The SS-N-25 version has been exported to India for fitting to the Delhi class destroyers (project 15). with four quadruple launchers per ship, for fitment to later Khukri class corvettes (project 25A) with 12 missiles, to three Godavari class frigates (project 16)



An SS-N-25 /SCC-6 missile shown in front of its launch canister in 1993 (Alan Luto)

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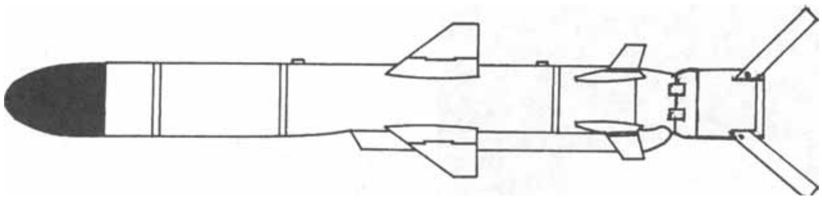


A line diagram of the SS-N-25/SCC-6 missile

with 16 missiles, to three improved 'Krivak 3' class frigates (type 1135.6) with 16 missiles each, and to Veer (type 1241RE 'Tarantul 1) FSG. It is reported that an initial order for 100 missiles was placed by India in 1997. There was a reported sale of SS-N-25 missiles to Vietnam in 1997, for fitment to two Ho-A class (type 124) fast attack craft with each carrying eight missiles. In 1998, Algeria ordered 96 missiles, believed to be for fitting to modernised 'Nanuchka' corvettes and 'Koni' frigates, although later reports suggest the missiles were AS-20 for use on Su-24 'Fencer' aircraft. In February 2001 it was reported that China was negotiating to purchase AS-20 missiles for use on their Su-30MKK aircraft.

Specifications

ASM version (AS-20)
Length: 3.75 m
Body diameter: 0.42 m
Launch weight: 480 kg
Payload: Single warhead; 145 kg
Warhead: HE SAP
Guidance: Inertial with active radar
Propulsion: Turbofan
Range: 130 km, 300 km (mod 1)
Accuracy: n/k

SSM version (SS-N-25)/(SSC-6)
Length: 4.2 m
Body diameter: 0.42 m
Launch weight: 630 kg, 700 kg (mod 1)
Payload: Single warhead; 145 kg
Warhead: HE SAP
Guidance: Inertial with active radar
Propulsion: Solid propellant boost and turbofan
Range: 130 km, 250 km (mod 1)
Accuracy: n/k

Contractor

Zvezda-Strela OKB, Korolev, is the prime contractor. Granit Central Research Institute developed the surveillance radar and fire control system. Taifun Instrument Plant in Kaluga built the coastal defence TEL and vehicles, and Radar MMS at St Petersburg developed the active radar seeker for the missile.

SS-NX-26 (3M55 Oniks/Yakhont)(PJ-10)/SSC-X-5 (Bastion)

Type
Short-range, air-, ship-, submarine- and ground-launched, ramjet-propelled, single-warhead, air-to-surface and surface-to-surface missiles.

Development
First exhibited in 1993, this anti-ship cruise missile was originally developed by NPO Mashinostroenia (was previously the Chelomei OKB) in two versions. The ship-launched version has the Russian designator 3M55 Oniksfor the missile, and 3K55 for the complete system, and has been given the NATO designator SS-NX-26. The Russians have given the export missile the name Yakhont. The coastal defence ground-launched version has the same Russian designators, but has the export name Bastion. This second version has the NATO designator SCC-X-5. It is reported that development started in 1985, with the requirement to provide a lighter weight follow-on system to the SS-N-9 'Siren', SS-N-19 'Shipwreck and SS-N-22 'Sunburn' surface-to-surface missile systems. In 1999 an air-launched version was reported to be in development, and this was displayed in August 1999. This version may have the name Alfa, or this name may apply to the complete system. The air-launched version will probably be cleared for carriage on MiG-29 'Fulcrum', Su-27, Su-30. Su-32 and Su-33 'Flanker' aircraft carrying two missiles, and on Tu-142M 'Bear F' aircraft carrying up to 8 missiles. A submarine-launched version has been proposed, and may also be in development. This version may be fitted to 'Yasen' class (type 885) attacksubmarines, and could be launched from a new design vertical launch system with eight launchers per boat, and with each boat carrying up to 24 missiles. A land attack missile with GPS (or Glonass) added to the guidance system has also been proposed, and presumably this could be applied to all the launch variations.

In 2002 it was reported that an improved active radar seeker was being developed for greater accuracy.

In August 2001, a joint venture between NPO Mashinostroenia and DRDO India, was announced, to design and develop a version of the Yakhont missile known as PJ-IO. The joint company is called BrahMos, and the agreement was signed in February 1998, with development work starting in July 1999. It has been suggested that the PJ-10 missile will be fitted to the Admiral Gorshkov aircraft carrier, if this is modernised for the Indian Navy. Further PJ-10 missiles may be developed for submarine launch, for coastal defence, and for use from aircraft such as the MiG-29 'Fulcrum' and Su-30 MKI 'Flanker'.

Description
The SS-NX-26 missile is 8.9 m long, has a body diameter of 0.67 m and a launch weight of 3,000 kg. The nose has a circular air inlet for the ramjet motor, with a terminal seeker inside the intake bullet. There are four fixed delta wings at mid-body, and four moving delta wings at the rear for control during flight. The wings and fins are folded when the missile is in its launch canister. The missile is powered at launch by an integral solid-propellant boost motor, located in the ramjet nozzle section. The ramjet is a Plamya motor, similar in design to that used on the SS-N-22 'Sunburn' missile, and burns kerosene. The motor weighs 200 kg, and has a maximum thrust at sea level of 4,000 kg. This gives the missile a cruise speed of M2.6 at high level (14 km or 50,000 feet) or M2.0 at low level between 5 to 15 m altitude. SS-NX-26 has a maximum range of 300 km when cruising at high altitude, or 120 km when at low altitude. The minimum range is reported to be 50 km. Guidance in the cruise or mid-course phase is inertial, using a Siberian Devices and Systems ShYu 80-066 INS, and for the terminal phase there is a Granit radar seeker. The radar seeker is believed to be a dual-mode active/passive radar, with a range of 75 km in the passive mode and 25 km in the active mode. The passive radar detects the ship target at long range, the missile then descends to low level to avoid detection, and switches on the active radar at around 20 km from the target. The missile can select an individual ship target from a group, even in a jamming environment. The terminal phase, which might be up to 40 km, is flown at low level, between 5 to 15 m altitude, with the missile making evasive manoeuvres near to the target to defeat any ship's defences. The warhead is a 250 kg HE SAP, although it is believed that a submunitions warhead might be developed later for land attack applications. The missile is stored in a

A PJ-10 Brahmos missile showing the turnover motor assembly at the nose (Kathryn Shaw) ***NEW***/0525201

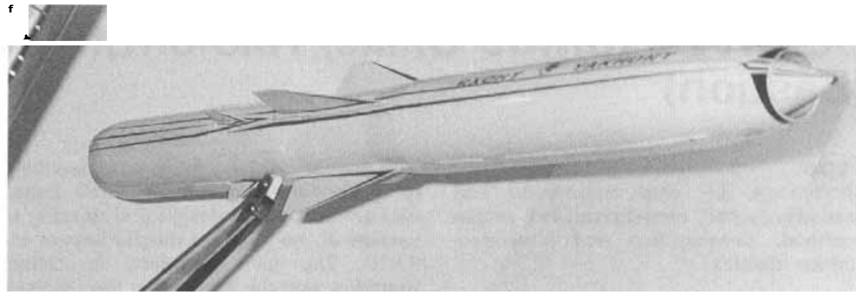
*An air-launched version of the 3M55 missile, displayed at Moscow in **August** 1999* (Piotr Butowski) 0089990

pressurised canister for 3 years between testing The canister is 9 0 m long, has a diameter of 0.7 1 m and an empty weight of 900 kg.

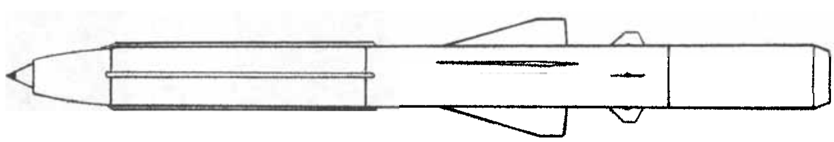
The coastal defence ground-launched SSC-X-5 (Bastion) version uses the same missile as the shiplaunched version, but a modified MAZ 543 (SS-1 'Scud B') transporter-erector-launcher vehicle carries three missiles in their canisters. Alternative launch vehicles have been offered, including the Kurgan KZKT-7428 1 and a lengthened Tatra T816 chassis. As an alternative, it is believed that silo-launching may also be offered. The missiles are reported to be launched directly from their canisters, which are fixed in the TELs at about 35" elevation. A coastal defence battery is expected to consist of a surveillance radar vehicle, a battery command vehicle, and up to eight TEL vehicles. In addition an aircraft or helicopter, probably a Ka-31 helicopter, could be used for over-the-horizon targeting.

The air-launched missile version has a length of 8.3 m, a body diameter of 0.67 m, and a weight of 2,550 kg. This version has folding wings and fins, and in addition has nose and tail covers fitted during carried flight. The covers are jettisoned just prior to launch. A smaller 200 kg HE SAP warhead is fitted. The initial version of this missile has inertial guidance, with a dual mode active/passive radar seeker for the terminal phase. The range is reported to be 500 km when released from high level (over 30,000 ft), and 200 km when released from low level. Later versions are planned to have INS/GPS guidance to attack land targets, and a longer range.

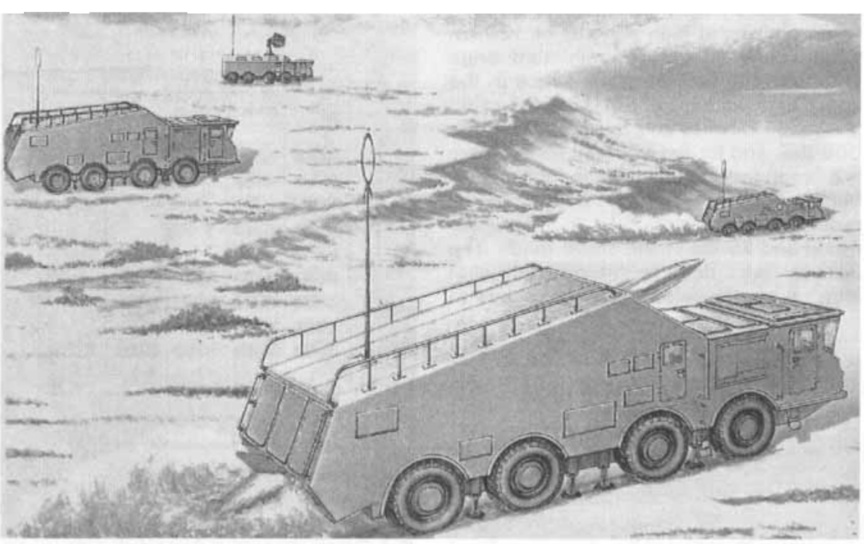
The PJ-10 version has an additional nose mounted turnover assembly, located at the nose over the ramjet air inlet. This is used to turn the missile onto the required azimuth trajectory following a vertical launch. The missile canister is mounted in a TPK vertical launch system for ship use, and the missile is cold launched from the canister up to around 25 m altitude. The turnover assembly has small rocket thrusters, and is jettisoned after use. An integral solid propellant boost motor ignites after turnover, and after accelerating the missile the main ramjet motor takes over. PJ-10 uses the smaller 200 kg HE warhead developed for the air-launched missile version. It is expected that India will use Kamov Ka-31 helicopters for target location, which will pass back target data to the launch ship.



A model of the SS-NX-26 (3M55 Oniks) ramjet-powered cruise missile, displayed in June 1997 (Duncan Lennox) *0022168*



Line diagram of Yakhont missile *NEW*/0116778



The SSC-X-5 (Bastion) coastal defence system depicted in an artists drawing (NPO Mashinostroenia) 0022167

Operational status

It is reported that development of the SS-NX-26 and SSC-X-5 system started in 1985 but, due to financial constraints, the system has been delayed awaiting formal Russian Federation funding. Around 25 firing trials had been conducted up to March 1997, and the system is not expected to enter service in Russia until 2002. Several countries were approached for joint development programmes in 1997, probably including China, India and Iran, and an unconfirmed report suggested that China may buy some SS-NX-26 (Yakhont) missiles to fit to two later 'Sovremenny' class destroyers instead of the SS-N-22 'Sunburn'. Iranian negotiations were reported to be continuing in 2001, probably for the air-launched version to fit onto MiG-29 or Su-24 aircraft.

The joint Russian/Indian PJ-10 version was first flight tested in India in June 2001, and production is planned to start in 2003 with a joint programme between Russia and India.

Specifications

Length: 8.9 m (SSM), 8.3 m (ASM)
Bodv diameter: 0.67 m
Launch weight: 3,000 kg (SSM), 2,550 kg (ASM)
Payload: Single warhead, 250 kg (SSM), 200 kg (ASM)
Warhead: HE SAP or submunitions
Guidance: Inertial with active/passive radar
Propulsion: Solid propellant boost and ramjet
Range: 300 km (SSM), 500 km (ASM)
Accuracy: n/k

Contractor

NPO Mashinostroenia, Reutov, Moscow. Russian production of the PJ-10 missile is expected to be carried out by NPO Strela at Orenburg, with final assembly and test by NPO Mashinostroenia.

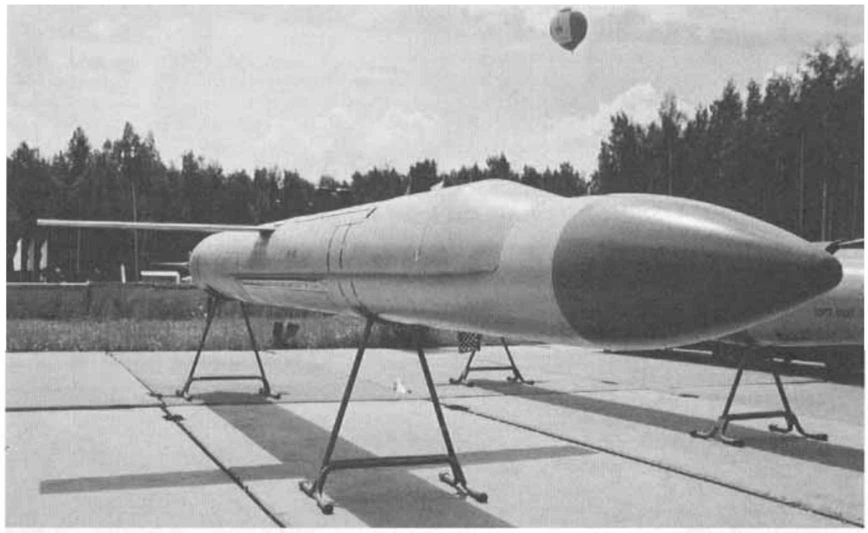
SS-NX-27 (3M14/3M54/91R1/91R2 Club)

Type

Short-range, ground-, ship- and submarine-launched, turbojet and solid propellant, single warhead, surface-to-surface missiles.

Development

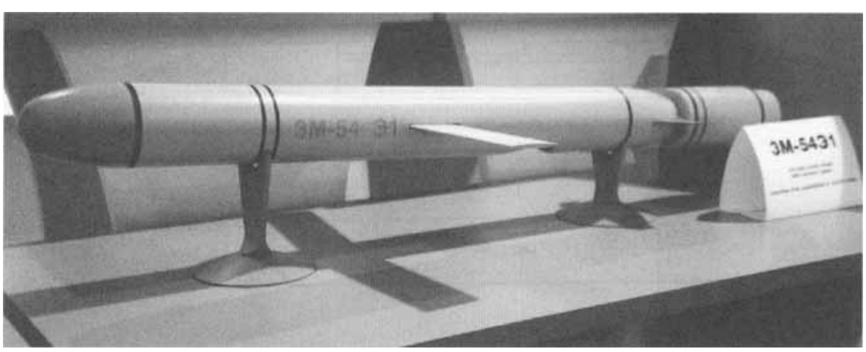
The Club family of missiles has been developed by the Novatur Experimental Design Bureau from 1985 and, although the 3M54 Biryuza missile was first displayed in 1993, the complete set of five missiles were offered for export from 1997. There are in effect three quite different missile designs within the one family, and while the NATO designator SS-NX-27 was given to the 3M54 missile first displayed in 1993, the NATO designators for the other missiles are unknown. The Russian export versions of these missiles have the designators with an added E, such as 3M54E. The Club family is divided into two categories, Club-S are submarine-launched, and Club-N are ship-launched.



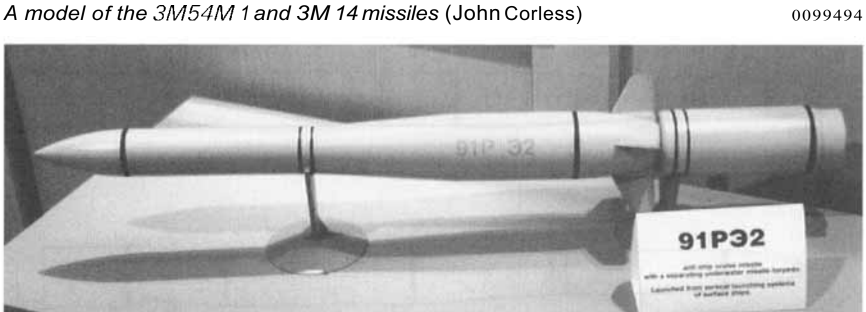
A 3M54 three-stage ***missile.*** *showing the distinctive nose shape and high wing position* (Miroslav Gyurosi) ***NEW***/0525184

In 1993, a wheeled TEL was offered for export, suggesting that a ground-launched category was also available, but recent descriptions have not mentioned the TEL option. The 3M54 (SS-NX-27) is a three stage anti-ship missile, which can be launched from a wheeled vehicle as a coastal defence missile, from ships or from submarines. The 3M54M1 is a two stage anti-ship missile, with a larger warhead and a longer range. The 3M14 is a land attack version of the 3M54M1 two stage missile. Both the 3M54M1 and 3M14 missilescan be launched from ships or submarines, and it is believed that both could also be ground-launched from a TEL vehicle. These three missiles are similar to the SS-N-21 'Sampson' (3M10/RK-55) nuclear strategic cruise missile design, also designed by Novatur, but with a greatly reduced range. The SSC-X-4 'Slingshot' ground-launched nuclear cruise missile was to have been launched from a 4 axle wheeled TEL with six missile canisters, but the programme was terminated following the 1987 INF treaty agreement. The wheeled TEL offered with the 3M54 missile in 1993 was similar to the TEL used by the SSC-X-4 missile system.

The last two missiles of the Club family are both anti-submarine missiles, carrying a torpedo. The 91R1 missile has two stages, a solid propellant motor and a torpedo, and is launched from submarines. The 91R2 has three stages with an additional boost motor assembly, and this missile is launched from ships. The Novatur design bureau developed the earlier SS-N-15 'Starfish' and SS-N-16 'Stallion' anti-submarine missiles, and the 91R1/2 designs are similar.



A model of the 3M54M 1 and 3M 14 missiles (John Corless) 0099494



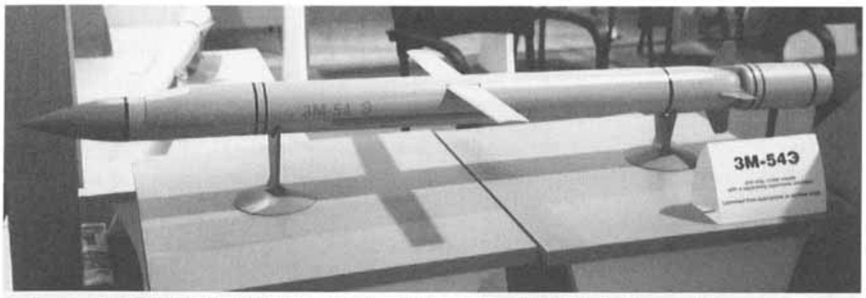
A model of a 91R2 missile (John Corless) 0099493

The Club family of missiles can be fitted to a wide selection of submarines and ships, and 3M54 missiles have already been fitted to Indian Sindhughosh class ('Kilo' class type 877 EKM and 636) submarines, with four missiles per boat. It is expected that they will also be fitted to Indian Talwar (project 17) ('Krivak 3' class project 1135.6) frigates, with eight missiles in a VLS. Russian submarines and ships could be re-fitted to carry the missiles, with reports indicating that Akula 1 and 2 (project 971). Oscar 2 (project 949B), Yasen (project 885). Lada (Amur) project 1650 submarines and Scorpion (project 12300) class corvettes may soon be carrying some Club missiles.

Description

The Club family of missiles can all be launched from a single 3P14 weapon fire-control system on a ship or submarine. They can be launched from vertical (3C14) or inclined launchers on ships, and through 533 mm torpedo tubes or from vertical launchers on submarines.

The 3M54 (SS-NX-27) anti-ship missile has three stages. The first stage is a tandem solid propellant boost motor assembly that is jettisoned after launch. The second stage has two straight chord rectangular wings mounted high in the body, and four small moving tail control fins. The second stage is powered by an Omsk TRDD-50 turbojet engine with a thrust of 480 kg. The engine has a scooped air inlet under the body, and an exhaust in the boat tail. The air inlet opens and the wings and fins are extended after the initial boost phase, at an altitude of 150 m. The third stage has a solid propellant motor and four flip-out control fins. The 3M54 has a total length of 8.22 m, a body diameter of 0.53 m, an extended wing span of 2.1 m, and a launch weight of 1,920 kg. The third stage contains the mid-course inertial guidance unit, a solid propellant motor, a 200 kg HE warhead and an active radar terminal seeker.



A model of a 3M54 (SS-NX-27) missile, displayed in 1999 (John Corless) 0099496

A model of a 91R1 missile (John Corless) 0099492

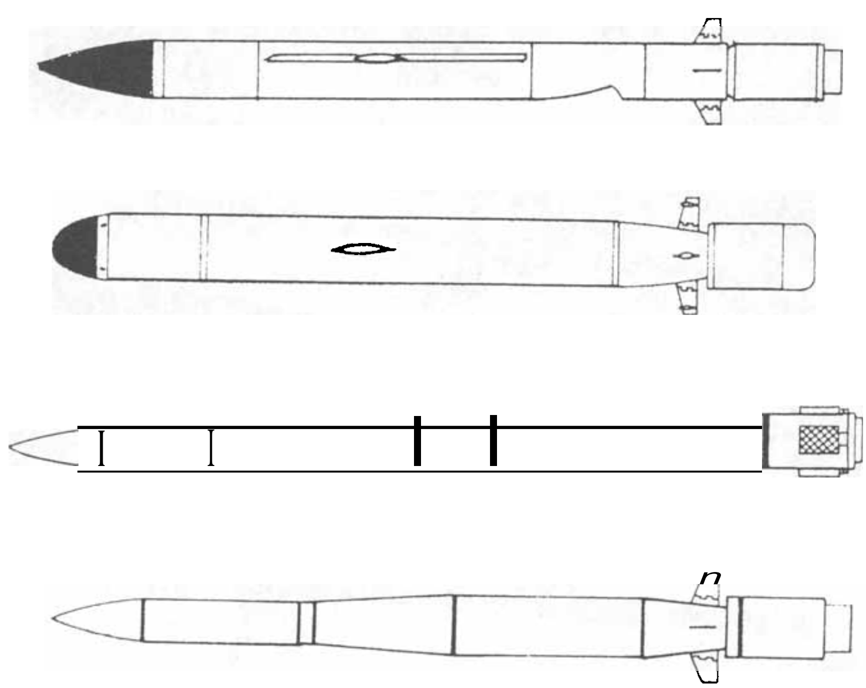
The terminal seeker is an ARGS-54 coherent active radar developed by Radar MMS, and this has a maximum range against a large ship target of 65 km, although it is expected that the terminal phase will be restricted to 20 km to provide less warning to the target ship. The active radar can scan ± 45" in azimuth and + 10 to −20° in elevation. The radar assembly weighs 40 kg without the radome, with a length of 0.7 m and a diameter of 0.42 m. The mid-course phase can be programmed for high altitude (over 10 km) or low level (10 to 15 m), with the turbojet engine providing a cruise speed of M0.55 to M0.8. The missile can be pre-programmed to climb at the end of a low level cruise, so that the active radar can acquire the target. The third stage of the missile separates from the turbojet engine section (second stage) at between 60 to 20 km from the target, and the terminal phase is flown at low level, at 5 to 10 m altitude, with the solid propellant motor providing a speed of M 3.0. The minimum range of the 3M54 missile is believed to be 20 km, and the maximum range is 220 km.

The 3M54M1 anti-ship missile is similar to the 3M54, but has a larger warhead, just two stages, and a longer range. The first stage is a tandem solid propellant boost motor assembly that is jettisoned after launch. The second stage has two straight chord rectangular wings mounted in the centre of the body, and four small moving tail control fins. The second stage is powered by an Omsk TRDD-50 turbojet engine that has a scooped air inlet under the body, and an exhaust in the boat tail. The air inlet opens and the wings and fins extend at the end of the boost phase, at an altitude of 150 m. The 3M54M1 missile has a length of 6.2 m, a diameter of 0.53 m, an extended wing span of 2.1 m, and a launch weight of 1,780 kg. The second stage contains the turbojet engine, the mid-course inertial guidance unit, a 400 kg HE warhead and an active radar terminal seeker. The terminal seeker is the same ARGS-54 fitted to the 3M54 missile. The missile has a cruise speed of M 0.55 to M 0.8 all the way to the target, and can be programmed for a high- or low-level mid-course cruise, followed by a terminal phase at 5 m altitude. The minimum range of the 3M54M1 missile is believed to be 20 km, and the maximum range is 300 km.

The 3M14 land attack cruise missile version is similar to the 3M54M1, but has a barometric altimeter for terrain following and a combined inertial navigation system with GPS/Glonass updates. The active radar seeker probably has terrain comparison algorithms for improved accuracy.

The 91R1 anti-submarine missile has a solid propellant motor as the first stage and a torpedo as the second stage. This version is submarine-launched, and can be launched from depths down to 150 m with the submarine moving at up to 15 kt. The first stage has four lattice-type moving control fins at the rear, and the missile is similar in shape to the SS-N-16 'Stallion'. The missile has a length of 8.0 m, a diameter of 0.514 m, and a launch weight of 2,050 kg. The 91R1 missile can be launched from standard 533 mm torpedo tubes or from vertical launch canisters. Following launch, the missile flies a ballistic trajectory and when in the target area the torpedo is released to enter the water separately. The torpedo is slowed by a brake parachute fitted to its rear section, so that it enters the water vertically. Several lightweight torpedoes can be fitted, but it is believed that the initial design uses an APR-3M torpedo fitted as the second stage. The APR-3M has a length of 3.2 m, a body diameter of 0.35 m, and a launch weight of 450 kg. The warhead is 76 kg HE and there is an active/passive sonar seeker. This torpedo has a solid fuel propulsion system, a range of 2 km, and can attack targets at a depth down to 800 m. It is believed that an alternative torpedo may be an improved type 40 APSET-95, with a length of 3.8 m, a diameter of 0.4 m and a launch weight of 620 kg. This torpedo probably has a range of 5 km and a speed of 45 kt. The 91R1 missile has a maximum range of 50 km.

The 91R2 anti-submarine missile is a smaller version of the 91R1, but with three stages. This version is for ship-launch, and can be launched from vertical (3C14) or inclined canisters. The first stage is a solid propellant boost motor, which is jettisoned after use. The second stage has a solid propellant sustainer motor and four small moving control fins at the rear. The third stage is a torpedo, and this is the same APR-3M torpedo as fitted to the 91R1 missile, although other lightweight torpedoes may also be fitted. The 91R2 missile has a length of 6.2 m, a diameter of 0.514 m and a launch weight of 1,200 kg. The reaction time for launch is 10 seconds.


Line diagrams for, 3M54 (top), 3M54M1 and 3M 14, 91R1, and 91R2 (bottom) 0099495

Specifications

	3M54	3M54M1	3M14	91R1	91R2
Length	8.22 m	6.2 m	6.2 m	8.0 m	6.2 m
Body diameter	0.53 m	0.53 m	0.53 m	0.514 m	0.514 m
Launch weight	1,920 kg	1,780 kg	1,780 kg	2,050 kg	1,200 kg
Payload	Single whd	Single whd	Single whd	Torpedo	Torpedo
Warhead	200 kg HE	400 kg HE	400 kg HE	76 kg HE	76 kg HE
Guidance	INS with active radar	INS with active radar	INS/GPS	INS with tercom sonar	INS with sonar
Propulsion	3-stage solid/ turbojet	2-stage solid/ turbojet	2-stage solid/ turbojet	2-stage solid/turbojet	3-stage solid/turbojet
Range	220 km	300 km	300 km	50 km	40 km
Accuracy	n/k	n/k	n/k	n/k	n/k

The missile has a maximum range of 40 km, and operates in the same way as the 91R1.

Operational status

The Club family of missiles have been in development in the Russian Federation for a long time, probably due to funding problems, and it is not known if any have been delivered to the Russian Navy for operational evaluation or in service use. In 1999 an export order for India was announced, with some missiles to be fitted to the Sindhughosh class ('Kilo' project 877 EKM and 636) submarines. These submarines have been fitted with the 3M54 Club missile system during refit, and a further boat fitted during its initial build in Russia. India is also reported to have selected 3M54 Club missiles for fitting in three Talwar class frigates (project 17) being built in Russia, with eight missiles per ship. It is reported that the 3M54M1, 3M14, 91R1 and 91R2 versions remain in development in 2002, awaiting production orders.

In 2000, it was reported that China was interested in ordering Club missiles for use in its 'Kilo' class (project 877 EKM/636) submarines, and for fitting into any further 'Sovremenny' class destroyers. Up to June 2002 over 20 Club-S and Club-N missiles had been tested in Russia and India, including six 3M54 missiles launched from Indian Sindhughosh class submarines.

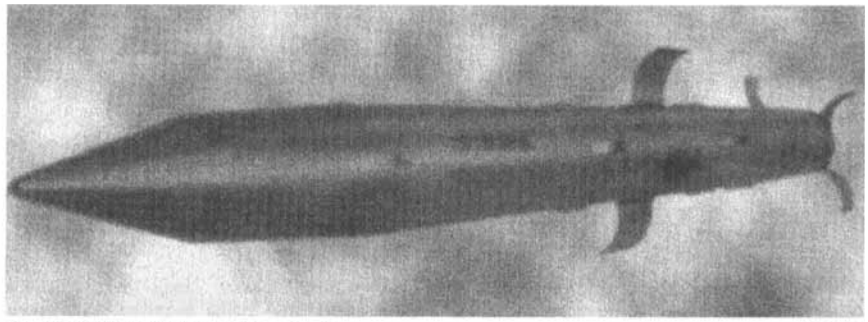
Contractor

Novatur Experimental Design Bureau, Yekaterinburg.

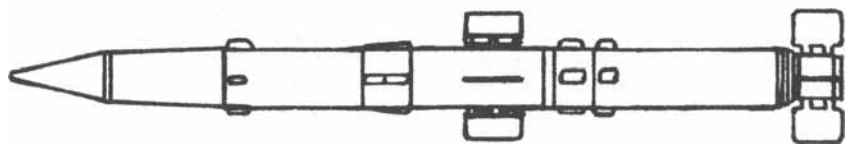
SS-N-29 (Medvedka)

Type
Short-range, ship-launched, solid-propellant, anti-submarine missile.

Development
Development of the SS-N-29 anti-submarine missile is believed to have started at the Moscow Institute for Thermodynamics in 1987, with trials in the Black Sea from 1993 to 1997. The trials used a coastal launch site and a 'Murka' class (project 1145) FAC-PHT hydrofoil with *two* quad launchers. The Russian name for the missile is Medvedka, although Grilltalpa has also been used. This missile, which carries a lightweight torpedo as its payload, was designed for use from small ships, with a displacement down to 350 tons. A vertical launch capability is being developed, with trials started in 1998. The missile will be cold launched, with a 'turn-over' assembly added at the rear with four control fins. The turn-over assembly will be jettisoned after use.



An SS-N-29 anti-submarine missile 0062332



A line diagram of the SS-N-29 missile 0062331

Description
The SS-N-29 missile has four unfolding rectangular wings at mid-body and four unfolding moving control fins at the rear. The missile has a length of 5.35 m, a body diameter of 0.4 m, and a launch weight of 750 kg. The missile is coated with a fire-retarding material. The payload can be a Gidropribor type 40 lightweight torpedo, which has an active/passive acoustic sensor and can attack targets between 15 and 500m depths. The torpedo has a diameter of 0.324 m, a weight of 450 kg, and can be fitted with several warhead types. It is believed that the warhead most commonly used is a 60 kg HE. Other lightweight torpedo types can be fitted. The SS-N-29 missile has a solid propellant motor that can be pre-programmed for thrust duration, with a minimum range of 1.5 km and a maximum range of 25 km. The missile has a simple inertial system for guidance; the range is determined by the fire control system before launch and controlled by terminating the thrust, and the launcher assembly is pointed towards the target to achieve the required azimuth direction.

The missiles are carried on a lightweight aluminium alloy launcher assembly with two or four missile canisters per launcher. The launcher assembly is raised to the computed elevation and azimuth prior to launch, but the launcher is not stabilised. The launcher can rotate through 360°. The type 40 torpedo is ejected from the missile over the target area, and descends by parachute. The parachute is discarded as the torpedo hits the water, and the torpedo then describes a shallow spiral downwards until the target submarine is acquired. The torpedo motor is then started and the solid propellant motor drives the torpedo towards the target at up to 115 kt.

Operational status
It is believed that initial low rate production started in 1995, and that SS-N-29 entered service in 1997. However, reports from Russia suggest that the missile has not entered full rate production, and that the Russian Federation does not have funding authorised for further purchases. The missiles are fitted to one trials ship, the hydrofoil 'Vladimirets' with eight missiles There are no known exports.

Specifications
Length: 5.35 m
Body diameter: 0.4 m
Launch weight: 750 kg
Payload: Type 40 torpedo 450 kg
Warhead: 60 kg HE
Guidance: Inertial
Propulsion: Solid propellant
Range: 25 km
Accuracy: n/k

Contractors
Moscow Institute of Thermodynamics is the prime contractor. The torpedo was developed by NII Gidropribor at St Petersburg, the fire control system was developed by Granit Central Research Institute, and the missile is manufactured by the Votkinsk GNPO.

AS-4 'Kitchen' (Kh-22 Burya)

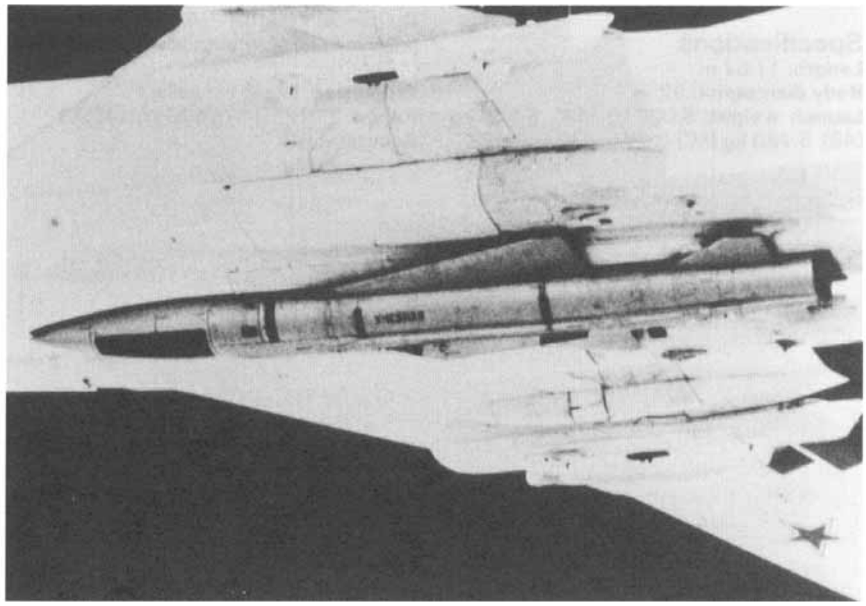
Type

Short-range, air-launched, liquid-propellant, single-warhead air-to-surface missile.

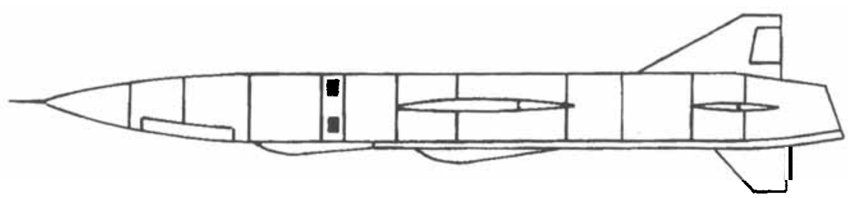
Development

The AS-4 'Kitchen' is the NATO designation for a missile that was developed in the late 1950s to early 1960s. AS-4 is believed to be called *Burya* by the Russians, and has the designator Kh-22. There were three major versions of this missile developed. The first version, AS-4A, has the Russian designator Kh-22NA, and this has a nuclear warhead. The missile was developed as a replacement for AS-3 'Kangaroo', and this version of AS-4 has inertial mid-course and no terminal guidance. AS-4A started development in 1960, and entered service in 1965 on Tu-16 'Badger' aircraft. The second version, AS-4B. has the Russian designator Kh-22MP. This version has a large conventional High Explosive (HE) warhead and a passive radar guidance head for attacking ship and land-based long-range surveillance radars. AS-4B started development in 1969, and entered service in 1975 on Tu-22 'Blinder' and 'Backfire' aircraft. A third version, AS-4C. has the Russian designator Kh-22N. This version has a HE semi-armour piercing warhead and an active radar terminal seeker. AS-4C started development in 1983, and entered service in 1987 on Tu-95 'Bear' aircraft. A report in 1999 suggested that a major upgrade programme had been started in 1995, which was extending the life of existing missiles as well as developing a further improved version, probably with a dual mode active/passive radar seeker. It is expected that the Kh-32 missile will eventually replace the Kh-22.

AS-4 missiles have been cleared for carriage on Tu-16 'Badger', Tu-22M3 'Backfire' and Tu-95K-22 'Bear'. The Tu-22M3 can carry three missiles, one under each wing and one in the bomb bay. The bomb bay missile is lowered before launch on a BD-45F extending pylon.



AS-4 Kitchen air-to-surface missile being carried beneath the fuselage of a Tu-22M3 Backfire' aircraft



A line diagram of an AS-4 'Kitchen' missile 0062330

Description

The AS-4 'Kitchen' has two delta wings at mid-body, with all moving delta-shaped tails and fin at the rear. The rear fin is folded during aircraft carriage. The missile is 11.67 m long, has a body diameter of 0.92 m, and a wing span of 2.99 m. The missile body is made from titanium alloy, to withstand kinetic heating during its high-speed flight. The height including the tail and fin is 1.81 m. Guidance in mid-course is inertial. AS-4 has a liquid-propellant motor, believed to use UDMH and IRFNA. The motor has dual chambers to provide variable thrust levels, and there are two exhaust nozzles at the rear of the missile. The thrust can be set at 80 kN for boost, and at 13.4 or 5.9 kN for cruise. The missile was designed for high-level release, from altitudes up to 22 km. The cruise altitude would normally be at between 10 and 14 km, with a cruise speed of M3.5 to M4.5, followed by a steep dive down onto the target in the terminal phase. The missile can also be released from low level, and can be programmed to cruise at altitudes as low as 1,000 m. The missiles are stored in canisters, which have a weight of 3,400 kg.

AS-4A (Kh-22NA) had a launch weight of 6,000 kg. This version had a nuclear warhead with a weight of 1,000 kg and a yield of 200 kT. Guidance was inertial, and this version would have been used against groups of ships or area targets such as cities. The maximum range was initially 310 km when launched from high level, and the minimum range was 140 km. The high-level cruise speed was M3.5. When launched from low level the maximum range was 200 km, and the minimum range 15 km.

AS-4B (Kh-22MP) has a launch weight of 5,900 kg. This version has a 930 kg HE blast fragmentation warhead with an active laser fuze. Guidance is inertial with a passive radar terminal seeker. This version is used against ship- or ground-based radars. The maximum range was initially 310 km when released from high altitude, but later upgrades increased this range to 350 km and then to 400 km. The minimum range is 140 km. The high level cruise speed is M4.0. When launched from low level the maximum range was 200 km, but this was increased to 250 km. The minimum range at low level is 15 km.

AS-4C (Kh-22N) has a launch weight of 5,780 kg. This version has a 930 kg HE semi-armour piercing warhead with optical and contact fuzes. Guidance is inertial with an active radar terminal seeker. This version is used against ship targets. The maximum and minimum ranges are the same as for AS-4B. except that the maximum cruise speed is increased to M4.5.

Operational status

AS-4A 'Kitchen' (Kh-22NA) missiles entered service in 1965 on Tu-16 'Badger' aircraft. AS-4B (Kh-22 MP) was designed for the Tu-22M3 aircraft, and entered service in 1975, and the AS-4C (Kh-22N) was designed for the Tu-95K-22 'Bear' aircraft and entered service in 1987. It is believed that about 350 missiles remained in service in 1991 fitted to 46 Tu-95K-22 'Bear B' aircraft located at Ukrainka in Russia, and to Tu-22M3 'Backfire C' aircraft.

In June 2002 Russia had no 'Bear-B' aircraft, and 66 Tu-22M3, and it is expected that around 250 missiles might have been retained. It is possible that some non-nuclear AS-4 missiles have also been retained by Ukraine, for use on their Tu-22M3 aircraft. An unconfirmed report in 1994 suggested that 12 Tu-22M 'Backfire' aircraft had been sold to Iran, with a number of AS-4 missiles, but this report is believed to have been incorrect. An improved version has been developed from 1995, and may have entered production in 2001. This version may be

exported to India, which has been reported to be negotiating for the lease of some Tu-22M3 'Backfire' bombers. Two missiles were flight tested in February 2001.

Specifications

Length: 11.67 m
Body diameter: 0.92 m
Launch weight: 6,000 kg (4A), 5,900 kg (4B), 5.780 kg (4C)
Payload: Single warhead; 1,000 kg (4A), 930 kg (4B/C)
Warhead: 200 kT nuclear (4A), HE blast (4B), HE SAP (4C)
Guidance: Inertial (4A), inertial with passive radar (4B), inertial with active radar (4C)
Propulsion: Liquid propellant
Range: 310 km (4A), 400 km (4B/C)
Accuracy: n/k

Contractors

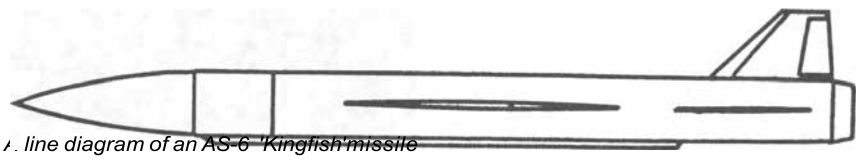
It is believed that Tupolev and Mikoyan (OKB-155) design bureau co-operated on the AS-4 design, with production from the Kharkov factory. AS-4 is supported now by Raduga NPO, Moscow and Dubna Engineering Plant, Moscow.

AS-6 'Kingfish' (Kh-26/KSR-5/KSR-11)

Type
Short-range, air-launched, solid-propellant, single-warhead air-to-surface missile.

Development
The AS-6 'Kingfish' is the NATO designation given to a missile that is extremely similar to the AS-4 'Kitchen', and was developed in the late 1960s to be lighter and to have a smaller radar cross-section together with a solid propellant motor. There are three major versions; the Kh-26 has inertial guidance and a nuclear warhead, Kh-26N has an active radar terminal seeker and either nuclear or HE warheads, and Kh-26MP has an anti-radar seeker with an HE warhead for use against land- or ship-based radar targets. The AS-6 first entered service in 1969, and there have been two further upgrades. It is believed to have the Russian designators Kh-26 and KSR-5 or KSR-11. The missile has been cleared for carriage on the Tu-16 'Badger', Tu-22M 'Backfire' and Tu-95M 'Bear' aircraft. In 1993, the Russians offered for export an air-launched target version of AS-6, with the designator KSR-5NM or KSR-5MV.


Two AS-6 'Kingfish' air-to-surface missiles being carried by a Tu-16 Badger aircraft


A line diagram of an AS-6 'Kingfish' missile

Description
The AS-6 'Kingfish' has two delta-wings at mid-body, with delta-shaped tails and fin at the rear. The missile is 10.56 m long, has a body diameter of 0.92 m, a wingspan of 2.6 m and weighs 4,500 kg. Guidance in mid-course is inertial and it is reported that there are three versions of terminal phase guidance, just as for the AS-4 'Kitchen'. One version has inertial guidance only and has a 350 kT nuclear warhead weighing around 1,000 kg. A second version has an active radar terminal seeker and is probably optimised for ship attack with either a nuclear warhead or a 930 kg HE SAP warhead. The active radar has a lock-on range of 25 to 30 km. The third version has a passive radar seeker and is used with an HE blast/fragmentation warhead to attack ship- or land-based radars. The AS-6 has a solid propellant motor and normally follows a high-level mid-course cruise profile, cruising at around 11 km altitude and at a speed of M 3.0. However, a low-level profile can also be flown, cruising at 50 m altitude at around M 2 0. The cruise phase is followed by a steep dive onto the target in the terminal phase, with a maximum range of 400 km when released from high level, and 250 km when released from low level.

Operational status
The AS-6 missile entered service in 1969, with a second version in 1973 for carriage on the Tu-95 'Bear', and a third version in 1976 for the Tu-95M. There were reported to be around 100 missiles still in service in Russia in 1990, but modified missiles have been offered for export as air targets and it is believed that all AS-6s had been removed from operational service by the end of 1994. The modified air target missiles were given the designators KSR-5NM or KSR-5MV. It is possible that some AS-6 missiles have been retained by Ukraine and, in 1994, an unconfirmed report indicated that a small number of missiles had been sold to Iran for use from Tu-22 'Backfire' aircraft. However, as there has never been any confirmation of Iran operating Tu-22 aircraft, it is assumed that the missiles were not sold.

Specifications
Length: 10 56 m
Body diameter: 0.92 m
Launch weight: 4,500 kg
Payload: Single warhead 930 or 1,000 kg
Warhead: 350 kT nuclear, HE or HE SAP
Guidance: Inertial, inertial with passive radar, inertial with active radar
Propulsion: Solid propellant
Range: 400 km
Accuracy: n/k

Contractor
It is believed that the AS-6 'Kingfish' missile was designed by the Tupolev and Mikoyan missile design bureau. The modification of the AS-6 missile for use as an air target was carried out by the Raduga NPO, Moscow.

AS-I 3 'Kingbolt' (Kh-59 Ovod)

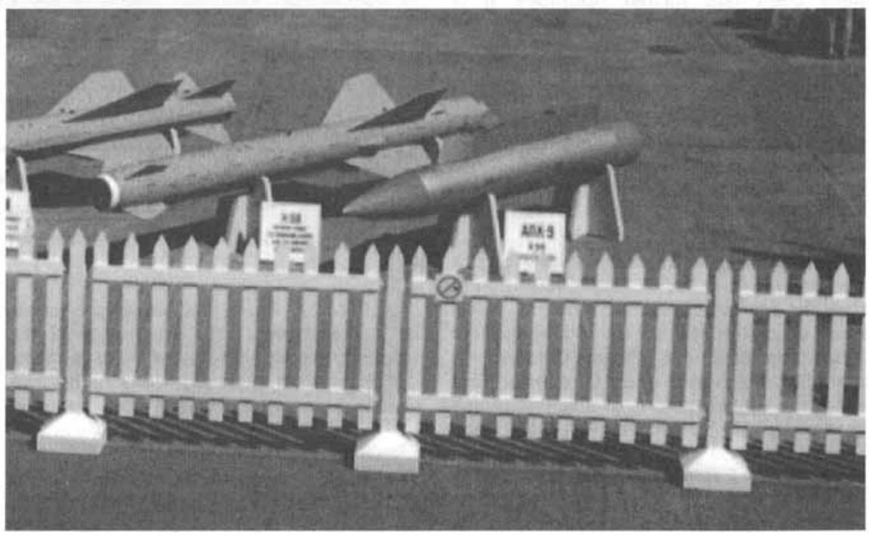
Type

Short-range, air-launched, solid-propellant, single-warhead, air-to-surface missile.

Development

Kh-59 Ovod is the Russian designator and name given to a TV command-guided air-launched missile. The missile has been given the NATO designation AS-I3 'Kingbolt' and was first seen in 1991 with an export designation of X-59. It is believed that the missile was developed in the 1970s by the Raduga OKB as a longer range, updated version of AS-IO 'Karen'. Development and manufacture of suitable EO sensors for use with Russian guided missiles is believed to have been carried out by the S A Zverev NPO in Krasnogorsk. Similar TV guidance systems are used on AS-I4 'Kedge' and the KAB-500 Kr family of *N* command-guided bombs. An upgraded variant, with the designator Kh-59M Ovod-M, was first seen in 1993. This design has an external turbojet engine mounted below the body just forward of the wings, and has the NATO designator AS-I8 'Kazoo' (for further details see separate entry). It is believed that the AS-I3 'Kingbolt' can be carried by the MiG-27 'Flogger', Su-17/22 'Fitter', Su-24 'Fencer' and Su-25 'Frogfoot' aircraft and that the APK-9 datalink pod is carried by the launch aircraft.

An export version of the AS-13 'Kingbolt' missile, exhibited in 1991 (Nick Cook) 0003147

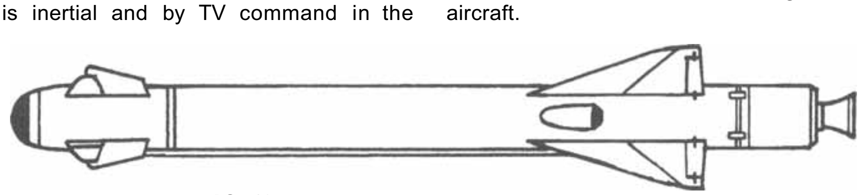


An AS- 13 Kingbolt missile and its associated APK-9 datalink pod (on the right), showing the nose and rear radomes on the pod (Nick Cook) 0003148

Description

In appearance the AS-I3 'Kingbolt' is unlike other Russian missiles of this period. Just behind the large rounded glass nose it has four fixed rounded stabilising nose fins, and these forward fins are reminiscent of the front end of the USA GBU-15, guided bomb. The glass nose has a protective cover for carried flight, which is jettisoned prior to missile launch. There is a strake running along the bottom of the missile's body to the rear-end command datalink antenna, and at the rear of the missile are four large clipped triangular wings, with elevator type control surfaces. The solid-propellant sustainer motor exhausts from two side mounted nozzles, situated between the leading-edge of the wings, and similar to those on the AS-7, AS-IO and AS-I2 missiles. The side mounted nozzles are to deflect the sustainer motor exhaust away from the datalink path, as the exhaust would attenuate the signals. The rear-mounted tandem solid-propellant booster motor assembly has a funnel type exhaust nozzle, and is jettisoned after burnout. The overall length of the AS-I3 before launch is 5.1 m, it has a body diameter of 0.38 m, a wingspan of 1.26 m and weighs 790 kg. AS-I3 is fitted with a 148 kg High Explosive (HE) warhead. The missile cruises at around M0.85. Guidance is inertial and by TV command in the terminal phase, and an accuracy of 3 to 5 m CEP is reported. The AS-I 3 'Kingbolt' is estimated to have a range of 40 km when launched from low altitude, and of up to 90 km when launched from medium altitude (30,000 ft).

An APK-9 datalink pod is carried by the launch aircraft, to receive TV pictures from the missile and send guidance commands from the operator back to the missile. The APK-9 pod is cylindrical in shape and carries a forward facing antenna system in a pointed radome and rearward facing antenna system a flat-ended radome. The pod is 4.0 m long, has a body diameter of 0.45 m and weighs 260 kg. In the West, the operation of such systems was usually carried out by a weapons operator in a two-seat aircraft, but the Russian designers appear to have reduced the workload so that the AS-I 3 can be fired from single-seat aircraft.



A line diagram of the ***AS-*** *13 'Kingbolt' missile*

Operational status

The AS-I 3 'Kingbolt' entered service with the Russian Air Force in 1980, and is believed to have been removed from service in the late 1990s. The export version, X-59, was offered for export along with other Russian air-to-surface missiles from 1991. However, it has not been advertised for export since 1998, and it is possible that it is no longer available. It is believed that AS-I3 was exported to Azerbaijan, Belarus, Kazakhstan and Ukraine.

Specifications

Length: 5.1 m
Body diameter: 0.38 m
Launch weight: 790 kg
Payload: Single warhead
Warheads: 148 kg HE
Guidance: Inertial and TV command
Propulsion: Solid propellant
Range: 40 km
Accuracy: n/k

Contractor

The AS-13 'Kingbolt' was designed by the Raduga OKB, Dubna, and was built at the Smolensk Aircraft Manufacturing Plant.

AS-I 5 'Kent' (Kh-55/Kh-555/RKV-500/Kh-65)

Type

Intermediate-range, air-launched, turbofan-powered, single-warhead air-to-surface missile.

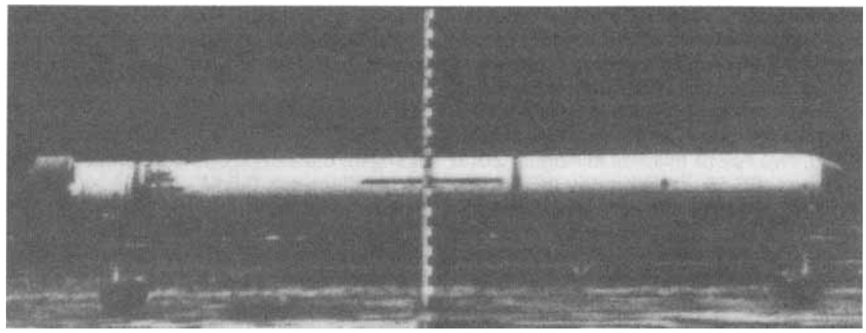
Development

The AS-I 5A 'Kent' is the NATO designation given to the air-launched cruise missile with the Russian designators Kh-55 and RKV-500A, and this missile was developed from 1971. The first test flight was made in 1976, and the missiles entered service in 1984. The longer range AS-I5B, with the Russian designators Kh-55SM and RKV-500B, entered service in 1987. The nuclear armed missile was believed to be similar to the US RGM-109 Tomahawk and little was known about the missile until December 1987, when the Russians released information on their similar Ground-Launched Cruise Missile (GLCM) the SSC-X-4 with the Intermediate-range Nuclear Forces (INF) Treaty declarations. It was believed that AS-I 5, SSC-X-4 and SS-N-21 were similar missiles, simply adapted for the different launch platforms, but it is now known that the AS-I 5 was different as its motor drops down below the missile during flight. The AS-15A 'Kent' (Kh-55/RKV-500A) could be carried by Tu-95MS 'Bear H' and Tu-142M 'Bear F' aircraft, and the AS-I 5B (Kh-55SM/RKV-500B) is carried by Tu-I 60 'Blackjack aircraft. Test flights were also made with Tu-26 (Tu-22M) 'Backfire' aircraft.

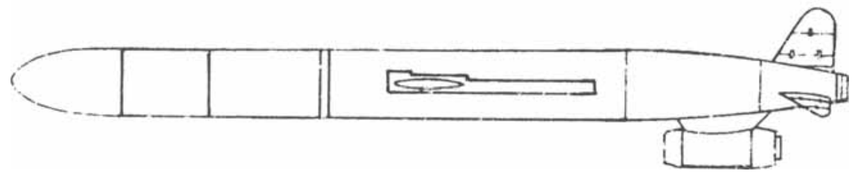
In 1992, the Russians released details of a conventional cruise missile variant of AS-I 5 'Kent' given the designator Kh-65SE, with a 410 kg High Explosive (HE) warhead and a fixed externally mounted turbofan engine beneath the rear body of the missile. This variant had a launch weight of 1,250 kg and a range of 600 km.

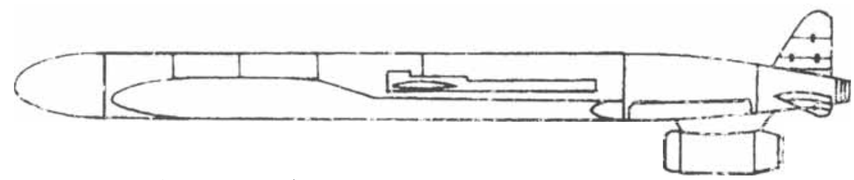
In 1999 a conventionally armed version, AS-I 5C was reported, with the Russian designators Kh-555, Kh-55Sh, Kh-55SD or Kh-55SE. It is reported that some AS-I 5A (Kh-55) missiles are being modified to the AS-15C (Kh-555) build standard. It is believed that development of the initial version was completed in 1996, but that further developments are continuing to provide improved guidance and a penetrating warhead.

The Tu-95 MS6 'Bear H6' and Tu-I 42M 'Bear F' carry six AS-15A missiles on an MKU-6-5U internal rotary launcher, and the Tu-95 MS16 'Bear H16' carries 16 AS-15A, with six on an internal rotary launcher and 10 externally in pairs on five underwing pylons. The Tu-I 60 'Blackjack carries up to 12 AS-I 5B missiles internally, in two rotary MKU-6-5U launchers.



An SSC-X-4 missile displayed in 1987, believed to be similar to the AS- 15A Kent' but with a tandem boost motor assembly fitted behind the tail fins 0038267





Line diagrams of the AS- 15A 'Kent' missile **(upper),** *and AS- 15B missile (lower)* ***NEW***/0116777

Description

The AS-I 5A (Kh-55) missile has straight flip-out wings with rounded tips at mid-body, and an all moving folding and rounded delta tail and fin assembly. The engine is stowed inside the rear body during aircraft carriage, and is lowered on a short pylon under the rear body at launch. It is believed that the engine is an Omsk MKB turbofan designated TRDD-50, with a thrust of 500 kg. This gives the missile a cruise speed of M0.5 to M0.8, and the cruise altitude is maintained at between 40 and 110 m by a radar altimeter. The missile has a length of 6.04 m, but this is increased to 7.1 m if a tandem-mounted boost motor assembly is attached for low altitude launch. The body diameter is 0.514 m, and the extended wing span is 3.1 m. The missile has a launch weight of 1,210 kg, which would be increased to 1,550 kg with a boost motor assembly. The payload has a weight of 410 kg and is fitted with a nuclear warhead with a yield of between 200 and 250 kT. Guidance is inertial, with a visual and IR camera for terrain comparison and map-matching to update the inertial system and to provide terminal guidance. An accuracy of 25 m CEP has been reported. The missile can be launched from an altitude of 200 to 12,000 m. AS-I 5A has a minimum range of 50 km and a maximum range of 2,500 km.

The AS-I 5B (Kh-55SM) missile is similar in size and shape, but has conformal fuel tanks mounted each side of the missile body. These tanks are deeper forward of the wings, and extend aft nearly to the engine pylon. The body diameter is increased to 0.77 m, and the launch weight to 1,500 kg. If a tandem boost motor assembly is added, the launch weight becomes 1,700 kg. The maximum range of AS-I 5B is increased to 3,000 km, but the other specifications are as for AS-I 5A.

The AS-I 5C (Kh-555 or Kh-55SE) missile is similar to the AS-I 5B with conformal fuel tanks, but with the nuclear warhead replaced with a 400 kg HE or submunitions warhead. This version has *two* small canard guidance fins at the nose to provide a smaller CEP. It is believed that AS-15C has an active radar terminal seeker, although it could have a radar or optical correlation seeker. The maximum range is believed to be 3,000 km.

Operational status

AS-15A 'Kent' test flights are believed to have started in 1976, and the missile entered service in 1984. The longer range AS-15B version entered service in 1987. The AS-15C, HE warhead version, is believed to have entered service in 1997, although these may only have been operational evaluation missiles. Further development for penetration warheads is believed to be continuing, with a possible in-service date of 2003. In 1991 it is believed that around 1,800 AS-I5A/B missiles were in service, carried by 80 'Bear H' and 16 'Blackjack' aircraft. The AS-I 5 missiles were located at Mozdok in Russia, at Semipalatinsk in Kazakhstan and at Uzin and Priluki in the Ukraine. A 1999 report indicated that 1,612 AS-I5A/B cruise missiles were in the Ukraine in 1991, and in October 1999 the Ukraine and Russia finally agreed the terms of a transfer of aircraft and missiles. It was planned that Ukraine would return 575 AS-I5 missiles to Russia, with three

Tu-95MS and eight Tu-160 aircraft. The remaining 1,037 missiles were expected to be destroyed by Ukraine or modified with conventional HE or submunition warheads to the AS-I 5C version.

It is believed that all the AS-15 missiles from Kazakhstan have been returned to Russia. Russia test-launched two AS-I 56 missiles in October 1996, two AS-I5A in June 1999, two AS-15C missiles in April 2000, two AS-I 5 missiles in August 2000 and one AS-I5 in February 2001. The Mozdok airbase in Russia was closed in mid-1998, and it is reported that the bomber aircraft and AS-I 5 missiles have been transferred to Engels.

In June 2002 the Russian Air Force had 13 Tu-I60 'Blackjack aircraft based at Engels, and it is expected that a further three aircraft may be built. These aircraft are planned to carry AS-I 5B and AS-I 5C missiles. The Russian Air Force had 39 Tu-95MS6 and 32 Tu-95MS16 aircraft, based at Engels, Ukrainka and Ryazan-Dyagilevo, and these are expected to carry AS-I 5A and AS-I 5C missiles.

Specifications

AS-I 5A
Length: 6.04 m (7.1 m with boost motor)
Body diameter: 0.5 14 m
Launch weight: 1.210 kg
Payload: Single warhead 410 kg
Warhead: Nuclear 200 to 250 kT
Guidance: Inertial with terrain comparison
Propulsion: Turbofan
Range: 2,500 km
Accuracy: 25 m CEP

AS-I 5B/C
Length: 6.04 m (7.1 m with boost motor)
Body diameter: 0.77 m
Launch weight: 1,500 kg (1,700 kg with boost motor)
Payload: Single warhead 400 kg
Warhead: Nuclear 200 to 250 kT (15B), HE or submunitions (15C)
Guidance: Inertial with terrain comparison
Propulsion: Turbofan
Range: 3,000 km
Accuracy: 25 m CEP

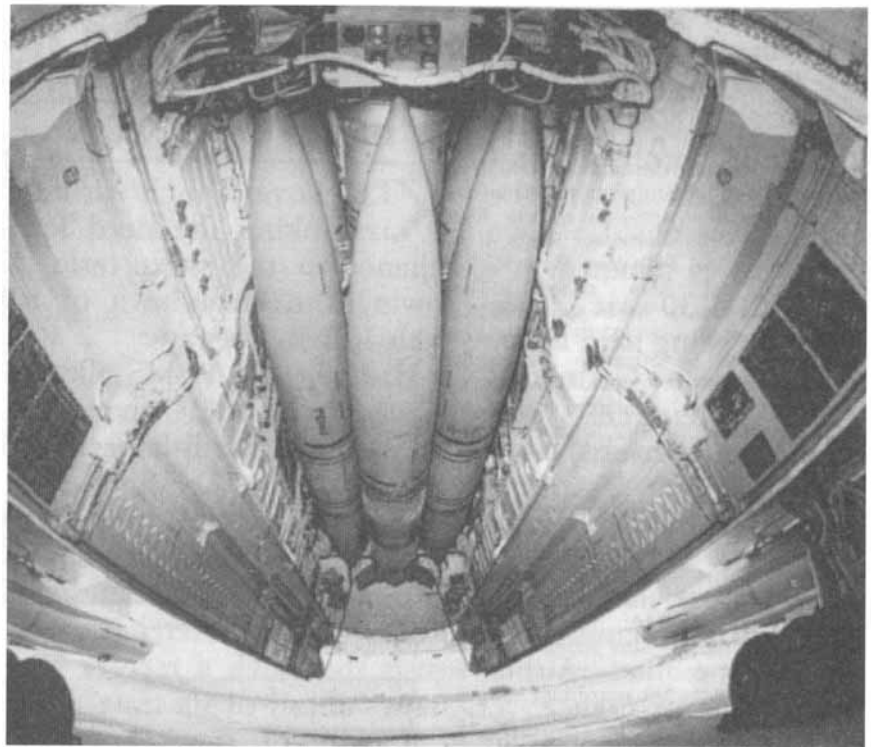
Contractor

It is believed that the AS-I 5 'Kent' missile was designed by the Raduga NPO, Dubna.

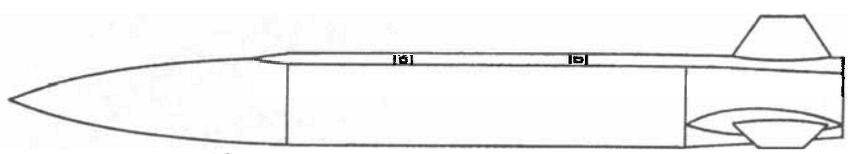
AS-16 'Kickback' (Kh-15/RKV-15)

Type
Short-range, air-launched, solid-propellant, single-warhead air-to-surface missile.

Development
Little was known about the existence of this anti-ship or anti-radar missile until the visit in 1988 by the US Secretary of Defense to Kubinka airbase to see the Tu-160 'Blackjack' bomber. NATO has given this missile the designator AS-16 'Kickback and it has the Russian designator Kh-15 or RKV-15. The Russians described their missile as equivalent to the AGM-69 Short-Range Attack Missile (SRAM) which entered service in the USA in 1972. The development timescale for AS-16 would most probably have been from the early 1970s and the missile is similar in shape to the AGM-69, but slightly longer and heavier. AS-16 was developed in three versions, as AS-4 and AS-6, with HE warheads for the anti-ship (Kh-15S) and anti-radar (Kh-15P) versions, and nuclear warheads for the area or ship group targets (Kh-15 or RKV-15). It is reported that this missile can be carried by Tu-95MS 'Bear H', Tu-22M3 'Backfire' and the Tu-160 'Blackjack' aircraft. The Tu-22M3 'Backfire C' carries six AS-16 missiles in an internal MKU-6-1 rotary launcher, and four missiles on two underwing pylons, for a total of ten missiles per aircraft. It is reported that the 'Blackjack can carry 12 AS-16 missiles internally, in two rotary MKU-6-1 launchers. Russia reported in 1991 that an improved version of AS-16, which was in development, had been cancelled, but a report in 1998 suggested that an upgraded AS-16 missile might be fitted to the Su-27M (Su-35) fighter bomber aircraft.



The rotary launcher of a Tu-22M3 'Backfire: showing six AS- 16 'Kickback' training rounds (ITAR-TASS)



A line diagram of the AS- 16 'Kickback' missile

Description
AS-16 is 4.78 m long, with a body diameter of 0.46 m and a tailspan of 0.92 m. The missile looks similar to the US AGM-69 SRAM, with a folding vertical fin and two tailplanes at the rear. Guidance is inertial in mid-course, with an active radar terminal seeker for the nuclear and HE warhead versions or a passive radar seeker for the anti-radar version. The Kh-15 nuclear and Kh-15P anti-radar version missiles have a launch weight of 1,100 kg, together with a 350 kT nuclear warhead or a 150 kg HE blast/fragmentation warhead. The Kh-15S anti-ship version has a launch weight of 1,200 kg, and has a 150 kg HE SAP warhead. With a solid propellant motor, the missile cruises at around M5.0 when at high altitude, and at up to M 2.0 at low level. AS-16 is reported to be able to cruise at altitudes between 30 m and 22 km. There is also a report that states that the missile can have a ballistic trajectory, reaching a maximum altitude of 40 km. The missile has a range of 150 km when released from medium altitude (30,000 ft) against a large ship target, and about 100 km when released from low level. The AS-16 has a minimum range of 40 km. It is reported that the solid propellant motor can be preprogrammed to stop and restart, to enable different high level or low level trajectories to be achieved. The missile can be released at altitudes between 300 m and 22 km.

Operational status
Developed during the 1970s. the AS-16 (Kh-15 version) entered service in 1980, as a nuclear armed cruise missile. The two other versions, the Kh-15P and Kh-15S, are believed to have entered service in 1988. In 1992, the Russians were offering the Kh-15 missile for export. It is believed that Ukraine has some HE warhead missiles in service. There are no other confirmed exports, although unconfirmed reports have stated that a factory has been set up in China to manufacture a nuclear air-to-surface missile system, which could be AS-16 'Kickback'. The AS-16 missiles are probably located at Engels, Ukrainka and Ryazan-Dyagilevo, together with the Tu-95MS6/16 and Tu-160 aircraft.

Specifications
Length: 4.78 m
Body diameter: 0.46 m
Launch weight: 1,100 kg (15/15P), 1,200 kg (15S)
Payload: Single warhead 150 kg
Warhead: Nuclear 350 kT (15). 150 kg HE blast (15P), 150 kg HE SAP (15S)
Guidance: Inertial (15). inertial with passive radar (15P), inertial with active radar (15S)
Propulsion: Solid propellant
Range: 150 km
Accuracy: n/k

Contractor
It is believed that the AS-16 'Kickback missile was designed by the Raduga NPO, Dubna.

AS-17 'Krypton' (Kh-31P/A)

Type

Short-range, air-launched, ramjet-propelled, single-warhead air-to-surface missile.

Development

Kh-31 is the Russian designator and X-31 is the export designation given to this air-to-surface anti-radar/anti-ship missile first seen at the 1991 Dubai Air Show. It is reported that AS-17 'Krypton' is the NATO designator for this missile. The development programme began in the late 1970s as a follow-on to AS-12 'Kegler', but with improved performance specifically aimed at countering the US MIM-104 Patriot and RIM-67 Standard missile air defence systems. In 1992, Russian reports indicated that the missile was being developed/produced for use with interchangeable homing heads; a passive anti-radar seeker and an active radar seeker for use in terminal guidance against ship targets. The passive radar variant is designated Kh-31P, and the active radar anti-ship missile Kh-31A.

The same reports also suggested that there were at least two versions of the Kh-31P with different maximum ranges, and that studies were in progress for the use of the longer ranged missile against Airborne Early Warning (AEW) aircraft in the air-to-air mode. An MA-31 variant of the Kh-31 missile is used as a supersonic target for ship defence training. From its appearance Kh-31P/A was a totally new concept with four ramjet motor air inlets, and unlike any missile the Russians had designed before. The missile was not unlike the US former LTV designed ramjet-powered research missile, which flew in 1974.

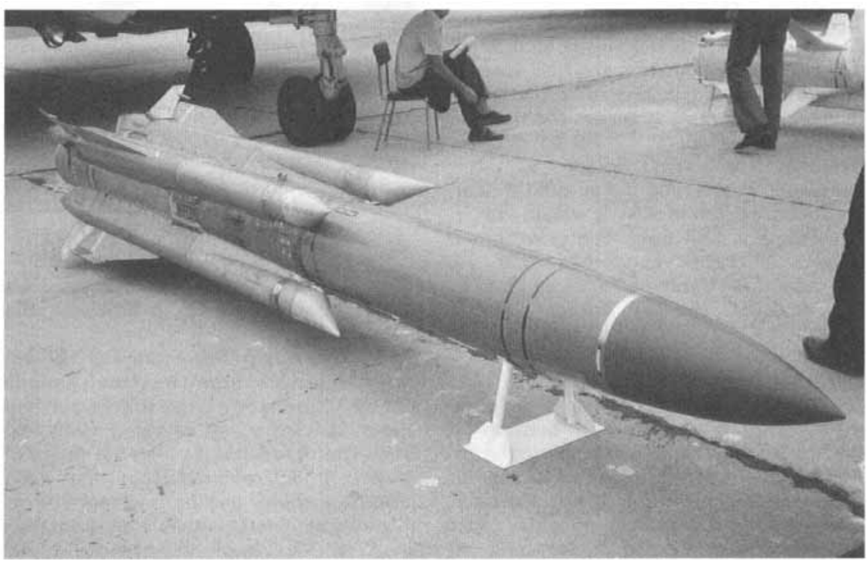
The Russians researched integral rocket/ramjet propulsion systems in the 1960s. with the Toropov OKB-134 design team developing the SA-6 'Gainful' surface-to-air missile system (Russian designation ZRK-SD Kub) which entered service in 1970. It is reported that the ramjet for Kh-31 was designed by the Soyuz Turaevo Machine Design Bureau at Lytkarino in Russia. There are reported to be further design studies for Kh-31 to be developed into a new family of air-to-surface missiles.

In 1998, a joint Russian/Chinese programme was reported, with a modified Kh-31P anti-radar missile to increase the range to around 400 km, designated KR-1 in Russia and possibly Ying Ji-9 or Ying Ji-91 in China. However, in 2000, pictures of YJ-91 showed a missile with quite different air intakes to Kh-31, looking more like the French ASMP missile with two rectangular air intakes. Kh-31P was designed by Zvezda-Strela and a small number exported to China, and it is believed that the Chinese will make further missiles under licence. An improved seeker for the anti-ship version (Kh-31A) was reported to be in development in 1999, probably dual band mmW/X-band with a range of 60 km and capable of refining the aim point on the target ship.

The supersonic target version, designated MA-31 in Russia, was selected for evaluation by the US Navy in 1994 and a joint trials and evaluation programme was set up between Zvezda-Strela and McDonnell Douglas (now Boeing). Flight trials started in 1996, with launches from US Navy OF-4 Phantom aircraft against ship targets and 13 missiles were modified by Boeing for these tests.

The AS-17 'Krypton' (Kh-31P/A) missile has been cleared for carriage on Su-17 'Fitter', Su-24 'Fencer', Su-25 'Frogfoot', Su-27, Su-30, Su-32, Su-33 and Su-35 'Flanker', MiG-21 'Fishbed', 'MiG-27 'Flogger', MiG-31 'Foxhound' and MiG-29 'Fulcrum' aircraft.

An AS-17 missile beneath an Su-27 'Flanker' ait-et-aft at Farnborough in 1994 (Duncan Lennox) 0003150



The AS-17 'Krypton' (Kh-31) air-to-surface missile displayed at the 1992 Moscow Air Show (Christopher F Foss)

Description

In appearance, the AS-17 'Krypton' (Kh-31) is similar to an early US design and the international (French/German) developed ANS air-to-surface missile. The missile has four long air intakes running from the centre of the missile to just forward of the boat tail. Towards the rear of each of these ducts there is a clipped delta-wing with a high-aspect ratio control fin very close to the trailing-edge. Each of the control fins has a small pitot type tube near its tip. From Russian documentation there would appear to be two different lengths of missile for both Kh-31P and Kh-31A versions.

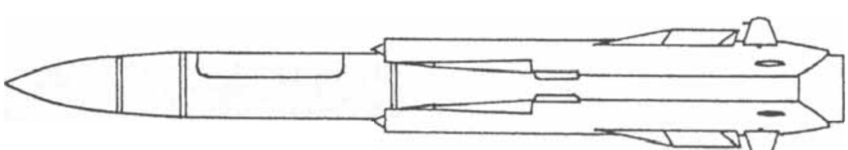
It is believed that the Kh-31P Mod 1 is 4.7 m long and the Mod 2 is 5.23 m long, has a body diameter of 0.36 m, a wing span of 0.8 m, and weighs 599 kg (Mod 1) or 625 kg (Mod 2) at launch. Guidance for the Kh-31P is passive radar homing, most probably with an inertial supplement to enable homing to continue even if the target radar is switched off. Unconfirmed reports suggest that there are three

An AS-17 'Krypton' air-to-surface missile displayed at Farnborough in 1996 (Duncan Lennox) 0003149

interchangeable homing head assemblies, to target different radar frequency bands. The missile has an 87 kg HE blast/fragmentation warhead. The minimum range is 15 km and the maximum is 110 km for the Mod 1 version when launched from medium level; the maximum range for the Mod 2 version is increased to 200 km from medium altitude. The MiG-27 'Flogger' aircraft usually carry an APK-8 radar emitter-locator pod when fitted with Kh-31P missiles, to provide more accurate target position and frequency data to the missiles before launch. An accuracy of 8 m CEP has been reported.

The Kh-31A Mod 1 missile is 4.7 m long and the Mod 2 is 5.23 m long, with all other dimensions being the same as the Kh-31P. The Mod 1 missile weighs 610 kg, and the Mod 2 version weighs 700 kg. Kh-31A guidance is inertial, with an active radar terminal seeker. In 1997, an ARGSN-31 active radar seeker for use in the Kh-31A missile was displayed, with a weight of 39 kg, a range of 20 km, azimuth coverage of ± 20° and an elevation coverage from +10 to –20°. This missile can be launched at up to 8" from the azimuth bearing of the target. The seeker has a maximum lock-on range of 10 km from a frigate-sized target. The Mod 1 version has a 95 kg HE semi-armour piercing warhead, and the Mod 2 version has a 110 kg HE SAP warhead. The minimum range is 5 km and the maximum is 70 km for the Mod 1 version when released from medium level, and 100 km for the Mod 2 version. Kh-31A is reported to have an accuracy of 8 m CEP. The MA-31 target is reported to have similar range capabilities to the Kh-31A missile version.

Both missiles are launched from an AKU-58 rail launcher. The Kh-31 has an integral solid propellant boost motor, followed by a ramjet sustainer motor using the solid propellant motor casing as a combustion chamber. When launched, the solid propellant boost motor accelerates the missile to M1.8, at which point the ramjet ignites and continues to accelerate the missile to its cruise speed of M2.5 at low level or M3.0 at high level. The Kh-31 missile can cruise at low altitude down to 200 m, or at high altitude (50,000 ft/15 km) followed by a steep dive down onto the target. The missile is reported to climb briefly at about 2 km from the target and to be able to manoeuvre at up to 10 g during the terminal phase, to avoid ship defence missile and gun systems.



A line diagram of the AS-17 'Krypton' missile

Operational status

The AS-17 'Krypton' (Kh-31) was first displayed and offered for export at the 1991 Dubai Air Show, along with a variety of other air-to-surface missiles all of which are in service and still in production. It is reported that the Kh-31P entered service in Russia in 1988, followed by the Kh-31A in 1989. Most of the existing in-service missiles in Russia are believed to be to the Mod 1 standard, with the increased range Mod 2 standard missiles offered for export. It is believed that some older Mod 1 missiles may have been upgraded to the Mod 2 standard from 1998 onwards. A small number of modified Kh-31P missiles, with the designator KR-1, have been exported to China, and it is believed that China will build similar missiles under licence.

An MA-31 anti-ship target variant of the Kh-31A missile was evaluated by the US Navy, and following the delivery of 13 missiles, flight tests started in 1996. It is believed that a programme for 100 MA-31 target variants was agreed in 1999, and the first batch of 34 missiles were delivered to Boeing for conversion to targets in early 2000.

Specifications

Kh-31A
Length: 4.7 m (Mod 1), 5.23 m (Mod 2)
Body diameter: 0.36 m
Launch weight: 610 kg (Mod 1), 700 kg (Mod 2)
Payload: Single warhead; 95 kg (Mod 1), 110 kg (Mod 2)
Warhead: HE SAP
Guidance: Inertial with active radar
Propulsion: Solid propellant and ramjet
Range: 70 km (Mod 1), 100 km (Mod 2)
Accuracy: 6 m CEP

Kh-31P
Length: 4.7 m (Mod 1), 5.23 m (Mod 2)
Body diameter: 0.36 m
Launch weight: 599 kg (Mod 1), 625 kg (Mod 2)
Payload: Single warhead; 87 kg
Warhead: HE blast/fragmentation
Guidance: Inertial with passive radar
Propulsion: Solid propellant and ramjet
Range: 110 km (Mod 1), 200 km (Mod 2)
Accuracy: 8 m CEP

Contractors

The Kh-31 missile was designed by the Zvezda-Strela OKB, Korolev. The propulsion system was designed by the Soyuz Turaevo Machine Design Bureau, Lytkarino.

AS-18 'Kazoo' (Kh-59M Ovod-M)

Type
Short-range, air-launched, turbojet-propelled, single-warhead, air-to-surface missile.

Development
This missile is a turbojet-powered version of the AS-13 'Kingbolt' (Kh-59 Ovod), and it is believed that development started on the AS-18 in the mid-1980s. The AS-18 'Kazoo' has the Russian designator Kh-59M Ovod-M, sometimes shown as X-59M for export. Details of this weapon were first released in 1992, and the missile was exhibited in 1993. A ship-launched version has been offered for export with a tandem-mounted boost motor, giving a total missile weight of 1,000 kg, but it is not known if this version has entered service in Russia. A report in 1995 suggested that an increased range (200 km) version was in development, and in 1999 this was offered for export as the Kh-59ME. An unconfirmed report in 1999 stated that an imaging IR seeker was in development for AS-18.

In 2001 a third missile version was offered for export, with the designator Kh-59MK. All the assemblies will be built in Russia, transferring manufacture from the Ukraine. This version has a new turbofan engine, a range of 285 km, and an active radar seeker. The Russians may have developed a nuclear warhead for AS-18, for use from Su-27 'Flanker' aircraft, and it is possible that this version has the designator Kh-20.

It is believed that AS-18 has been cleared for carriage on the same aircraft that carry AS-13, believed to be MiG-27 'Flogger', Su-24 'Fencer' and Su-25 'Frogfoot'. It is expected that AS-18 will also be carried on the Su-27M 'Flanker' (Su-35), Su-30M, Su-32FN and Su-34 aircraft.

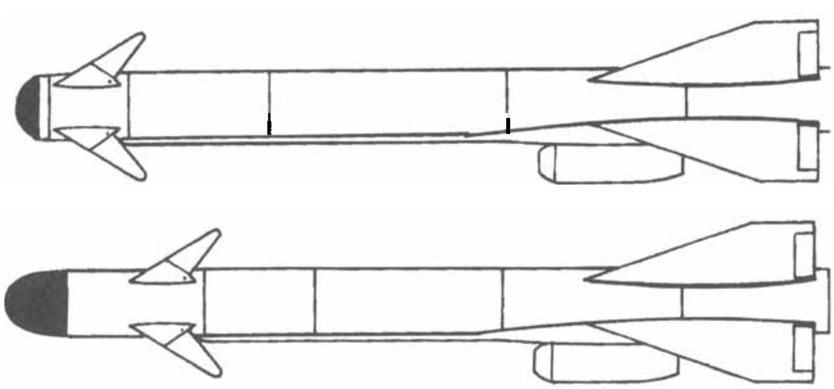
An AS-18 'Kazoo' missile displayed at Farnborough in 1996 (Duncan Lennox) 0038268

Description
The AS-18 'Kazoo' is similar to the AS-13 'Kingbolt', but has a pod-mounted turbojet engine under the rear body of the missile. The engine is a Soyuz R-95-300 with a thrust of 300 kg. The missile has a length of 5.1 m, a body diameter of 0.38 m, a wingspan of 1.17 m and a launch weight of 850 kg. Guidance in mid-course is inertial with command updates, and there is a TV command guidance system used for the terminal phase. The aircrew receive a data linked picture from the TV camera in the nose of the missile, and place a marker on their display over the selected target with the resultant control signals relayed to the missile back over the data link.

The launch aircraft carries a data link pod, the same APK-9 pod used in the AS-13 'Kingbolt' system, which is 4.0 m long, has a diameter of 0.45 m, and a weight of 260 kg. The AS-18 has a 315 kg HE semi-armour piercing warhead, although there is a report of an alternative submunition warhead with a weight of 280 kg. If a nuclear warhead was fitted, then it is expected to have a selectable yield between 10 and 100 kT. The missile flies at low level, which can be set at 7 m over water or at 100 m, 200 m, 600 m or 1,000 m over land, at about M0.8. The maximum range with lock-on before launch is 40 km, and with aircrew updates is 120 km. The minimum range is about 20 km. A Russian report gives the accuracy as 5 m CEP. The AS-18 missile is carried on the AKU-58 pylon-mounted rail launcher.

The upgraded version, designated Kh-59ME, has a length of 5.6 m, a body diameter of 0.38 m, a wingspan of 1.3 m, and a launch weight of 920 kg. This version has a 320 kg HE semi-armour piercing warhead. One unconfirmed report suggests that this version cruises at M 1.5, at altitudes set between 50 and 1,100 m. The maximum range has been increased to 200 km.

The Kh-59MK version has a length of 5.7 m, a body diameter of 0.42 m, and a wing span of 1.3 m. The missile is similar in shape to Kh-59M, but has a longer nose section and different front canard fins. The launch weight is 930 kg, and the warhead is 320 kg HE semi-armour piercing. The engine is a Lyulka-Saturn 36MT turbofan weighing 71 kg, with a thrust of 450 kg. This missile version does not have a boost motor fitted, but carries additional fuel to give a maximum range of 285 km. The minimum range is believed to be 5 km. Guidance in mid-course is inertial with command updates, but the terminal phase guidance is provided by an active radar seeker, which is a modified ARGS-35 seeker similar to that used in the SS-N-25/AS-20 missiles. This radar has a range of 25 km against a destroyer size target. Kh-59MK can be launched at altitudes between 200 and 11,000 m, and cruises at 10 to 15 m altitude in mid-course, followed by 4 to 7 m altitude during the terminal phase.



Line diagrams of the AS-18 'Kazoo' missile, with the Kh-59M above and Kh-59MK below
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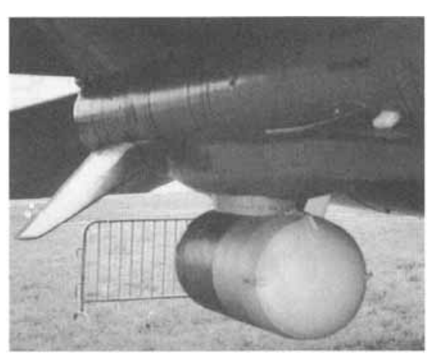


A close-up view of the turbojet engine under an AS-18 missile, with the inlet cover in the carried flight position
(Duncan Lennox) 0003151

Operational status

It is believed that the AS-18 'Kazoo' (Kh-59M) entered service in 1991, and it was first offered for export in 1992. However, unconfirmed reports indicated in 1994 that only early production missiles were in service, and that full production was still being negotiated. The present position is unclear. The Kh-59ME version is in development, with a range of 200 km, and this was offered for export in 1999. It is believed that a trials launch was made in China in April 2001, and that this version has been ordered by China for use from the Su-30MKK aircraft. The Kh-59MK version may also have been ordered by China, and it is believed that development started in 2001, with test flights expected to start in 2002.

Specifications

Length: 5.1 m (M), 5.6 m (ME), 5.7 m (MK)
Body diameter: 0.38 m (M/ME), 0.42 m (MK)
Launch weight: 850 kg (M), 920 kg (ME), 930 kg (MK)
Payload: Single warhead
Warhead: HE 315 kg or submunitions 280 kg (M), HE SAP 320 kg (ME/MK)
Guidance: Inertial with updates and TV command (M/ME), and active radar (MK)
Propulsion: Turbojet (M/ME), turbofan (MK)
Range: 120 km (M), 200 km (ME), 285 km (MK)
Accuracy: 5 m CEP

Contractor

The AS-18 missile was designed by the Raduga NPO, Dubna, and built at the Smolensk Aircraft Manufacturing Plant.

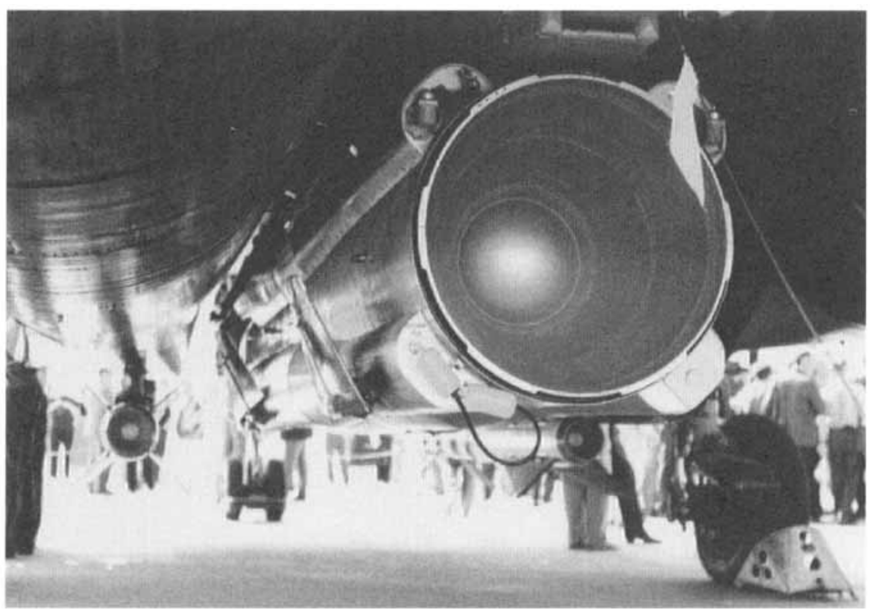
Kh-41 (3M82/Moskit/P-100/P-270)

Type
Short-range, ship- and air-launched, ramjet-propelled, single-warhead surface-to-surface and air-to-surface missile.

Development
The SS-N-22 'Sunburn' (3M80/P-80) surface-to-surface missile system entered service in 1980 and originally had a range of 90 km. An improved version of SS-N-22 was first exhibited at Moscow in 1992, where it was shown as an air-to-surface missile with the designators Kh-41, 3M82 and ASM-MSS, called Moskit (Mosquito). It is believed that a surface-to-surface version of Kh-41 is designated P-100 or P-270. and might be fitted to the later built Project 956A 'Sovremenny 2' class destroyers. There are also reports of a ground-launched coastal defence version of the P-270 missile. The missile is designed for use against individual ships or convoys and could have been intended as a replacement for the AS-4 'Kitchen' and AS-6 'Kingfish' air-to-surface missiles. From its appearance Kh-41 looks to be a larger version of the Kh-31 missile, with the integral rocket/ramjet propulsion system developed by the same OKB for both missiles. The Russians researched integral rocket/ramjet propulsion systems in the 1960s. with the Toropov OKB-134 design team developing the SA-6 'Gainful' surface-to-air missile system (Russian designation ZRK-SD Kub), which entered service in 1970. It is reported that the ramjet for Kh-31 and Kh-41 was designed by the Soyuz Turaevo Machine Design Bureau at Lytkarino in Russia.

It is believed that Kh-41 might be cleared for use on some Russian bomber aircraft, and has been seen fitted to the naval Su-27K variant 'Flanker' (Su-33) aircraft and could also be fitted to the Su-30 and Su-32FN.

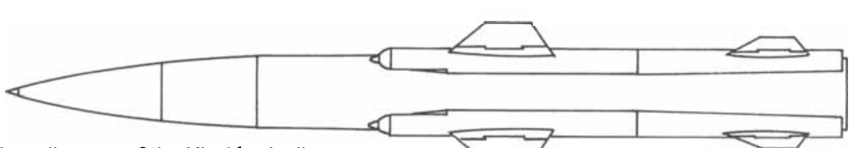
Close-up of the Kh-41 missile under an Su-27K Flanker' aircraft on display at the 1992 Moscow Air Show. The two other missiles are AA-10 'Alamo' air-to-air missiles (Piotr Butowski)


Rear end view of Kh-41 air-to-surface missile showing the integration of the solid propellant rocket nozzle in the aft end of the missile (note folded wings and rear fins along body) (Piotr Butowski)

Description
The Kh-41 is similar in appearance to the Kh-31 anti-radar air-to-surface missile, but is a great deal larger. The missile has four long air intakes running from just forward of the missile centre to the boat tail. There are four folding clipped triangular wings situated on and near the forward end of the intakes, with an extended span of 2.1 m, and four in-line folding fins at the rear.

The air-launched Kh-41 (3M82) missile is 9.74 m long, has a body diameter of 0.76 m and, with a 320 kg Semi-Armour-Piercing (SAP) warhead, weighs 4,500 kg at launch. Guidance is inertial with dual mode active/passive radar terminal seeker, which has an Electronic Counter-CounterMeasures (ECCM) capability. When carried on the Su-27K 'Flanker' the missile is launched from a large, integrated and shaped centreline pylon, with the aid of an integral solid propellant boost motor. The ramjet motor uses the solid motor casing as a combustion chamber (similar to Kh-31). The missile is reported to have a high-altitude (10 km) cruise speed of around M3.0, while the cruise speed at low altitude is M2.1. Range during a low-altitude, sea-skimming mission is up to 150 km. This range is reported to increase to 250 km when the missile follows a medium to high-altitude (23,000 to 65,000 ft) profile before diving to low altitude for the terminal attack phase. Although not mentioned in any released documentation, the Kh-41 is certainly capable of carrying a nuclear warhead.

The Russians have given little performance data for the ship-launched missile version, and this version is believed to have the designator P-270 with a maximum range of 160 km.


A l diagram of the Kh-41 missile

Operational status
A trials model of the Kh-41 was displayed at the 1992 Moscow Air Show. The air-to-surface version of this missile is believed to

have been terminated, as the Kh-41 was believed to be too heavy to be carried on fighter aircraft, and could only have been fitted to Tu-22M 'Backfire', Tu-95 'Bear' or Tu-160 'Blackjack bomber aircraft.

However, aircraft were still being displayed with the Kh-41 missile fitted up to August 2001, and so the status is unclear. A Russian report in 1997 stated that this missile might be fitted to the Su-32FN aircraft. Integration of Kh-41 missiles onto the Su-30MKI 'Flanker' export version for India were reported to have been completed in 1998, with two flight tests, and it is possible that export orders may be expected from both India and China for this version. The ship-launched version, P-270. is believed to have entered service in 1993 on the 'Sovremenny 2' class destroyers, and may be retrofitted onto 'Sovremenny 1' class as a replacement for the earlier SS-N-22 'Sunburn' missiles at a later date. A coastal defence version is also believed to be in development.

Specifications

Length: 9.74 m
Body diameter: 0.76 m
Launch weight: 4,500 kg
Payload: Single warhead; 320 kg
Warheads: HE SAP or nuclear
Guidance: Inertial with active/passive radar
Propulsion: Solid propellant and ramjet
Range: 250 km
Accuracy: n/k

Contractors

The Kh-41 missile design was by the Raduga NPO at Dubna, and the propulsion system was designed by the Soyuz Turaevo Machine Design Bureau, Lytkarino. The missiles are expected to be built at the Progress Plant, Arsenyev.

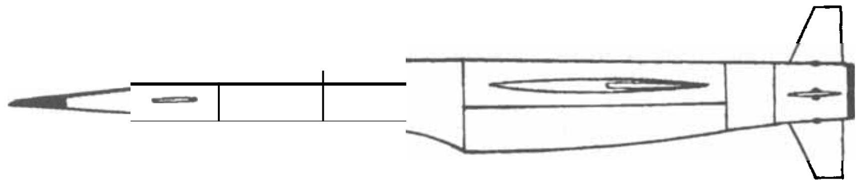
AS-X-19 'Koala' (Kh-90/BL10)

Type

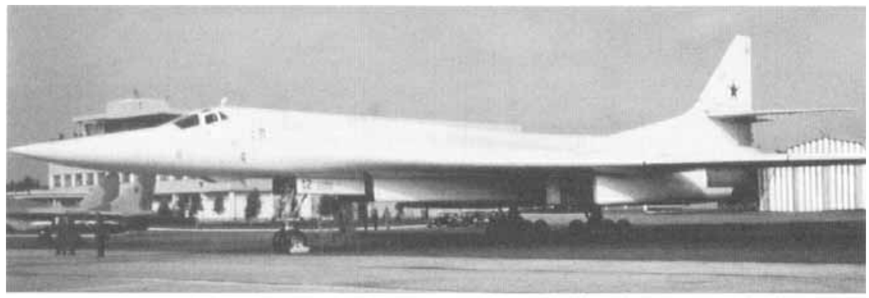
Intermediate-range, air-launched, turbojet-powered, single-warhead cruise missile.

Development

The existence of the AS-X-19 'Koala' had been reported by the US Department of Defense (DoD) in 1986, but was confirmed by the Russians in 1988, when the US Secretary of Defense was shown around a Tu-160 'Blackjack' bomber at an airbase near Moscow. The AS-X-19 was believed to have the Russian designator Kh-90 or BL10, and was reported to be a high-altitude supersonic cruise missile with air-launched, ship-launched and ground-launched versions, developed from 1976 and believed to have started flight trials in 1980. The AS-X-19 must therefore be considered as equivalent to the US AGM-129 advanced cruise missile programme, though probably several years behind. The programme was terminated in 1992, and it is reported that there were in excess of twenty flight trials. It is believed that AS-X-19 was a dual design for the Russian Air Force and Russian Navy, similar to the AS-15/SS-N-21 programme, with the SS-NX-24 'Scorpion' (P-750 Grom) variant to be launched from submarines. The AS-X-19 was expected to be cleared for carriage by Tu-95 'Bear-H' and Tu-160 'Blackjack' aircraft although it was reported that the Tu-95 could only carry two missiles. It is believed that Raduga NPO used the AS-X-19 design as a hypersonic test vehicle, known as GELA, and this has been used for research since 1994. In 1998, it was reported that the AS-X-19, or a lower cost variant, had been redesigned and might still be put into production for the Russian Air Force.



A line diagram of the AS-X-79 missile NEW/0525193



A Blackjack bomber, the carrier for the AS-X-19 air-launched cruise missile

Description

From reports in 1996, it appears that the AS-X-19 had two delta canard foreplanes at the nose, delta fins and tailplanes at the rear body and a long pointed slender nose. It is believed that the AS-X-19 was 10.5 m long, had a body diameter of 1.2 m and a wing span of 4 5 m. The larger delta-wings fold for aircraft carriage, and there was a vertical folding tail fin. The missile weight was 2,800 kg, and it was ramjet powered. The ramjet inlet was circular with a conical centrebody, and then a long slender nose section was shaped from the upper half of the body. Conventional flight control elevators and rudders were mounted on the wings and fin It is believed that the AS-X-19 could cruise at altitudes between 7 and 20 km at M4.5, and then made a steep dive onto the target. Unconfirmed reports suggest that the missile had two independently targeted warheads, capable of attacking separate targets 100 km apart. It is assumed that these warheads were to have been nuclear, but that any redesigned missile would have an HE warhead. The maximum range of AS-X-19 is reported to have been 3,000 km.

Operational status

The AS-X-19 was in development and some 20 or more flight tests had been made by 1992, when Russia indicated that the programme would be terminated. There are, however, indications that this AS-X-19 design has been retained, with the GELA hypersonic research vehicle, and that smaller missiles with turbojet or ramjet engines are being developed as possible lower cost replacements.

Specifications

Length: 10.5 m
Body diameter: 1.2 m
Launch weight: 2,800 kg
Payload: 450 kg
Warhead: Nuclear or HE
Guidance: Inertial
Propulsion: Ramjet
Range: 3,000 km
Accuracy: n/k

Contractor

It is believed that the AS-X-19 'Koala' missile was designed by the Chelomei and Raduga NPO design bureau.

RBS-I5

Type

Short-range, ship-, air- and ground-launched, turbojet-powered, single-warhead, surface-to-surface and air-to-surface missiles.

Development

The RBS-15 was developed as a new generation of anti-ship missiles suitable for use by naval vessels, coastal defence batteries and aircraft. It was clearly a development of the RB-04 and RB-08 missiles. Work started in 1979, when a development contract for a ship-launched version was placed with Saab Missiles (now Saab Bofors Dynamics), then in 1982 a further contract was placed for an air-to-surface version designated RBS-15F. The development contract for the coastal defence missile version, designated RBS-15K for the Swedish Coastal Artillery Force and RBS-15CD for export, was signed in 1986. The ship-launched version, RBS-15M, and the coastal defence version, RBS-15K, started a mid-life upgrade programme from 1995 to convert the missiles to a Mk 2 standard, with increased range and improvements to the mid-course guidance including the ability to turn 90° before the terminal phase. These upgrades included improved missile and fire-control system computers and software, to increase flexibility of target designation and acquisition as well as improving ECCM. An air-launched RBS-15F Mk 2 upgrade is planned to follow after the ship and coastal defence missile programme.

In 1995, design studies of a Mk 3 version were reported, with a more stealthy missile, highly manoeuvrable at high subsonic speed, and with a range in excess of 200 km. Development of the Mk 3 version continues, with three versions planned, for ship launch, ground launch and air launch.

In July 2000 an improved Mk 3 version was being proposed, with a low probability of intercept radar seeker, probably as part of a dual mode IIR/active radar seeker. This improved missile would also have GPS, a datalink, and a range increased to 400 km.

In 1996, it was reported that the possible launch of RBS-15 missiles to attack land targets from submarines was being investigated. The RBS-15 is fitted to missile corvettes of the 'Stockholm' and 'Goteborg' class with eight missiles in four twin-launch canisters, and to an experimental patrol craft. It is planned that the 'Visby' class corvettes will be fitted with eight missiles, to be launched from hatches on each side of the hull. Coastal defence missiles are fitted to wheeled truck TELs, carrying four missiles. The air-launched RBS-15F is cleared for carriage on AJ 37 Viggen and JAS 39 Gripen aircraft, with each aircraft capable of carrying two missiles.

An RBS-15F air-to-surface missile shown on the inner starboard wing pylon of a JAS 39 Gripen aircraft

An air-launched RBS-15F missile displayed at Farnborough in 1996 (Duncan Lennox)
0062329

Description

The RBS-15K Mk 1 coastal defence missile and the ship-launched RBS-15M versions are identical. They have four cruciform wings with ailerons for combined pitch and roll at the rear end, plus four canard fins at the nose for yaw control. There is a distinctive large engine air inlet located on the underside of the body just forward of the wings. The missile is 4.35 m long, 0.50 m in diameter and has a maximum unfolded wing span of 1.40 m (folded span is 0.85 m). Launch weight is 790 kg with the two jettisonable solid propellant booster motors. The sustainer motor used is a Microturbo TR 60-3 turbojet, which provides a cruising speed of M0.8 and weighs only 53 kg. The RBS-I5 has a maximum range of 100 km and a minimum range believed to be 10 km. The missile itself weighs 598 kg with a 200 kg HE blast/fragmentation warhead. Mid-course guidance is by preprogrammed autopilot with an FM-CW radio altimeter for height control. Terminal guidance is provided by a 9GR 4000 monopulse X-band frequency-agile radar. The search pattern set depends upon the target data available, and the final lock on mode can also be preset either as an active or active/home-on-jam operation. The airborne RBS-15F Mk 1 missile is similar to the ground- and ship-launched versions, but does not have the two solid propellant boost motors.

The RBS-15K and -15M Mk 2 missiles have a weight increased to 630 kg without the boost motors fitted and 800 kg with boost motors. The range is increased to 150 km, and this version has improved digital electronics, an improved seeker and carries more fuel. A Microturbo TR60-2 turbojet with a weight of 60 kg provides a thrust of 350 to 450 daN. The maximum cruise altitude is 12 km. The radar and infra-red signatures have been reduced. A new insensitive HE semi-armour piercing warhead is fitted.

The RBS-I5 Mk 3 missile system is expected to use a missile engagement planning system to automate raid planning and to allow for several missiles to attack from different directions with a co-ordinated time of arrival at the target. The size and weight are reported to be the same as for the Mk 2 missile. The range will be increased to over 200 km, and a new radar altimeter will allow cruise heights down to 1 to 3 m above the sea in the terminal phase. The active radar seeker will be upgraded to a monopulse high Ku-band (35 GHz) system. The missile will be able to fly overland, and to re-attack ship targets missed on the first pass. In the longer term the Mk 3 missiles may be given a land attack capability, including terrain comparison and GPS mid-course navigation updates, a command datalink capable of relaying back battle damage assessments, and a tandem hard target penetration warhead. In addition, the missile might carry its own flare decoys and radar jammer transmitter to assist in overcoming improved ship defences. Upgraded seeker options being considered include low probability of intercept radar,

synthetic aperture radar, and a dual mode active radar/imaging IR seeker. The Mk 3 ship- and ground-launched missiles will be housed in a new canister, which has a length of 4.42 m, a width of 1.2m, a height of 0.95 m and an empty weight of 800 kg.

Operational status

The ship, air and coastal variants are in production. The RBS-15M version entered service with the Royal Swedish Navy in 1985, and the coastal variant RBS-15K with the Royal Swedish Coastal Artillery forces as the RB-08A replacement. The air-launched RBS-15F version entered service with the Royal Swedish Air Force in 1989. The ship-launched and coastal defence RBS-I5 Mk 2 missile entered service in 1998, and there were two Mk 2 test launches made in 1997. The air-launched Mk 2 version is planned to enter service after 2000. Tests for the Mk 3 version started in 1997, with trials of the new radar altimeter in South Africa and a ground launch test of the new canister. The Mk 3 version started flight trials in 2000, and is expected to enter service in 2005.

The RBS-15CD has been exported to Finland, where it has been fitted to 'Helsinki' and 'Rauma' class fast attack craft. Some missiles were also exported to the former Yugoslavia as it is reported that Serbia and Montenegro have about 25 missiles. In addition, Croatia exhibited RBS-15 missiles in June 1995, with what are believed to be RBS-15M missiles mounted on specially adapted Tatra 815 6 × 6 trucks carrying four missile canisters. Croatia also has one 'Kralj' type 400 class corvette and one 'Koncar' type 240 class fast attack craft with four RBS-15 missiles each. It is believed that Croatia had around 100 missiles in 1995. Mk 3 missiles were selected by the German Navy in June 2001, to equip future K-130 class corvettes in a joint venture between Saab Bofors Dynamics and BGT. Also in June 2001, Finland placed a contract to upgrade its existing RBS-15CD missiles to an improved Mk 2 standard (known as SF3), and to increase their life by 15 years.

In August 2001, Poland ordered Mk 3 missiles to fit onto upgraded Orkan class (type 660) corvettes.

Specifications

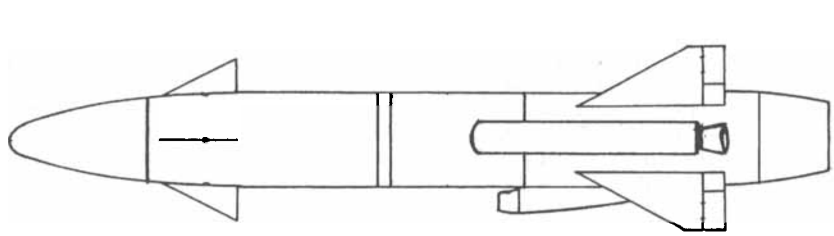
Length: 4.35 m
Body diameter: 0.50 m
Launch weight: 790 kg (Mk 1), 800 kg (Mk 2) (including boost motors), and 598 kg (Mk 1), 630 kg (Mk 2) for the air-launched versions
Payload: Single warhead; 200 kg
Warhead: HE blast/fragmentation, semi-armour-piercing
Guidance: Inertial and active radar
Propulsion: Turbojet
Range: 100 km (Mk 1), 150 km (Mk 2)
Accuracy: n/k

Contractors

Saab Bofors Dynamics AB, Karlskoga.
Microturbo, Toulouse, France (turbojet).

A Royal Swedish Navy Spica 2 'Norrköping' class missile boat with four aft-mounted RBS-15 surface-to-surface missile canisters

An early ground trials launch of the Swedish RBS-15 surface-to-surface missile



A line diagram of the RBS-15 missile

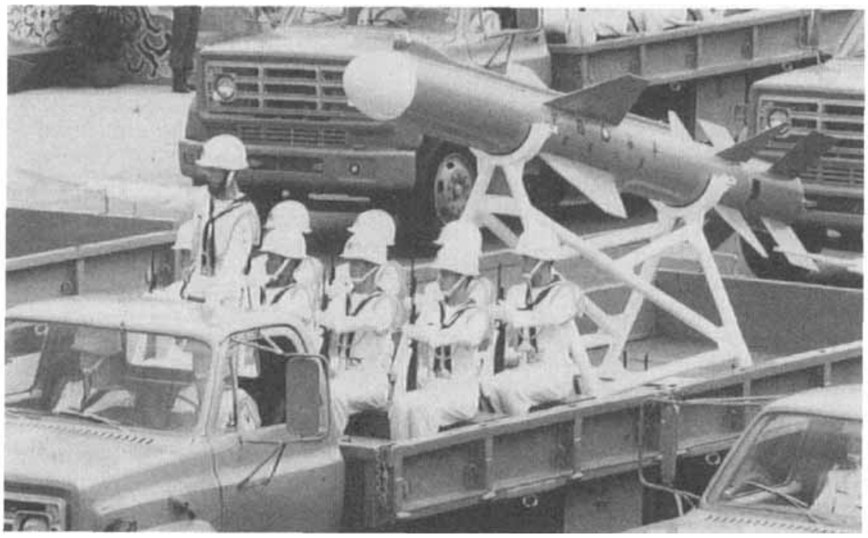
Hsiung Feng 1/2/3 (Male Bee)

Type
Short-range, ship-, air- and ground-launched, solid-propellant or turbojet, single-warhead, air-to-surface and surface-to-surface missiles.

Development
Hsiung Feng 1 (Male Bee) is the designation for the Taiwanese licence built version of the Israeli Gabriel Mk 2 anti-ship missile. The first trials firing was made in 1977 and production started in 1979. It is thought that the missile incorporates some Taiwanese design improvements. It is reported that a new radar seeker was developed and produced by the Sun Yat Sen Institute in co-operation with the licensee, the Chung Shan Institute of Research and Technology. Hsiung Feng 1 anti-ship missiles are fitted aboard Taiwanese destroyers of the US 'Gearing' and 'Allen M Sumner' classes in one triple- and two single-launch canisters, and one triple-launch canister respectively. The ground-launched version is carried on an articulated trailer, with three canisters per trailer.

Development of a longer range turbojet-powered version, Hsiung Feng 2, probably started in 1983 with the first trials firing in 1986. This missile is similar in appearance to the USA AGM/RGM-84 Harpoon. An air-to-surface version has also been developed. Hsiung Feng 2 missiles are fitted to the Taiwanese 'Cheng Kung' PFG-2 and 'Kang Ding' (La Fayette) class frigates, with eight launchers per ship, and in 'Hai Ou', 'Lung Chiang' and 'Jui Chiang' class fast attack craft with two or four single launchers each. It is planned that these missiles will also be fitted to the Kwang Hua 6 fast attack craft, with four launchers per boat. The air-launched version is carried by the IDF Ching-Kuo fighter, and is expected to be carried by the F-16 Fighting Falcon and Mirage 2000 aircraft. Reports in 1994 indicated that Hsiung Feng 2 missiles were also being used for coastal defence.

In 2001, it was reported that an improved version, Hsiung Feng 2, with a range of 150 km was in service, and that a new mobile TEL had been developed. It was also reported that a 500 to 600 km range Hsiung Feng 2E missile was in service, and that an extended range version, Hsiung Feng 2ER, was in development with a maximum range between 870 and 1,250 km. Unconfirmed reports in 1994 suggested that Hsiung Feng 3, a further development, had been proposed with a maximum range of 200 km. It is believed that this missile will have a land attack capability, and in 1998, the Chung Shan Institute of Research and Technology integrated a ramjet motor into a Hsiung Feng 2 missile body. The ramjet-powered version is reported to be too long to fit existing ship canisters and to be carried on aircraft, but it may be used for coastal defence. However, in 2001 it was reported that Hsiung Feng 3 would be ramjet powered and would have a maximum range of 300 to 600 km.

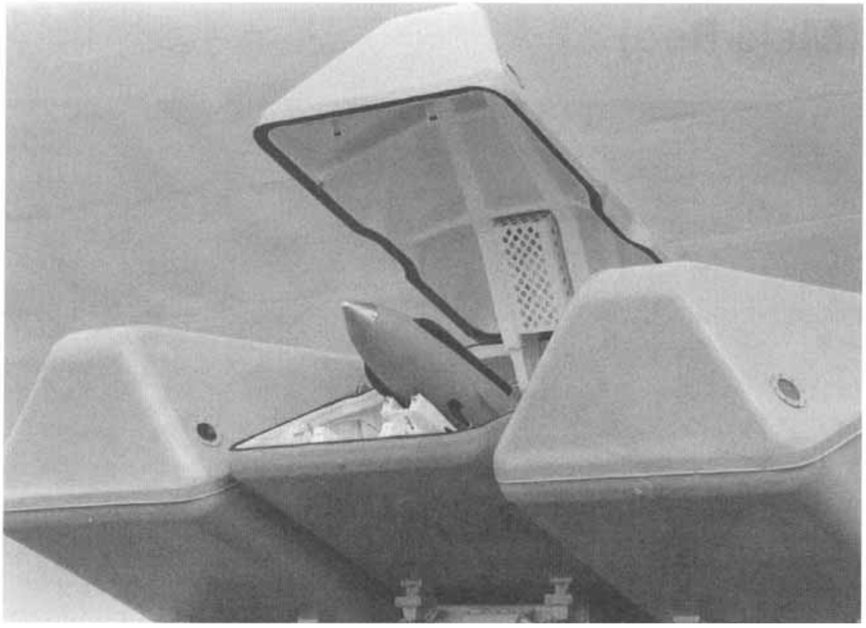


Hsiung Feng 2 turbojet-powered ship-launched surface-to-surface missile. showing the imaging IR seeker dome above the active radar seeker radome (MSP)

Hsiung Feng 1 coastal defence surface-to-surface missiles being shown on display in Taiwan, probably in the early 1980s

Description
Hsiung Feng 1 has cruciform rectangular moving control tailfins, which are in-line with larger rectangular mid-body wings. The missile is similar in appearance to the Israeli Gabriel Mk 2 missile. The missile is 3.42 m long, has a body diameter of 0.34 m and weighs 522 kg at launch. Before launch the missile guidance system is programmed with the target data obtained from the associated search radar. The missile is then fired and under control of its twin gyro autopilot, assumes an initial cruise altitude of about 100 m (328 ft). At a range of 7 km from the launcher the onboard autopilot commands the missile to descend to 20 m altitude using a radio altimeter to maintain the height. At a predetermined distance from the target the terminal semi-active radar is switched on, the target is acquired and the missile descends to one of its three possible preset attack altitudes for the final run-in. The actual set altitude varies between 1 and 3 m and depends upon the sea state encountered at the time. Propulsion is by a solid propellant sustainer motor with a solid booster. The effective missile range is reported to be 35 km with a cruise speed of M0.7. The HE semi-armour-piercing warhead weighs 180 kg, and contains some 75 kg of conventional HE. The ground-launched version is the Honeywell H 930 mobile coastal defence system, which includes a CS/UPS-60 surveillance radar and a CS/SPG-24 engagement radar developed from the RCA R-76 I-band naval radar system.

Hsiung Feng 2 bears little resemblance to its predecessor the Hsiung Feng 1, but



A close-up of the Hsiung Feng 1 missile nose assembly in an open canister

appears to be similar to the AGM/RGM-84 Harpoon, with the exception of the four tailfins which are triangular in shape. The missile is 4.6 m long, has a body diameter of 0.34 m, a wing span of 0.9 m and a launch weight around 685 kg. Guidance is inertial for mid-course with a dual mode imaging IR and active radar terminal seeker, and the range is around 80 km. The imaging IR seeker is contained in a 70 mm diameter strake located above and just behind the radome. There have been reports that provision has been made for mid-course command guidance from external sources, such as a helicopter or aircraft carrying out over-the-horizon targeting. Propulsion is by turbojet with the launch phase being assisted by a jettisonable solid propellant booster. The Hsiung Feng 2 has a larger 225 kg HE warhead. The air-to-surface missile version has no boost motor, and has a reduced length of 3.9 m, and a reduced launch weight of 520 kg. The maximum range is 80 km. An improved version of Hsiung Feng 2 is reported to have a range increased to 150 km. A further version, Hsiung Feng 2E, is reported to have a range increased to 500 to 600 km, and it is believed that this missile is longer and heavier, and has extending wings added. The Hsiung Feng 2ER version is believed to have a length of 6.25 m, an extended wing span of 2.67 m, and a launch weight of 1,440 kg. This version is believed to have a range of between 870 and 1,250 km.

Hsiung Feng 3 is believed to be ramjet powered, and to have an integral solid propellant boost motor. The launch weight is reported to be 1,500 kg. The missile can be air-launched or ground-/ship-launched from vertical launch canisters. The maximum speed is reported to be M2.0 to M2.3, and the maximum range between 300 and 600 km. It is possible that the Hsiung Feng 3 shares a common airframe and guidance system with the Hsiung Feng 2ER missile, but with a larger body diameter, probably 0.42 m.

Operational status

Hsiung Feng 1 has been in service with the Taiwanese Navy since 1980, and the coastal defence system is also currently deployed. It is reported that 500 Hsiung Feng 1 missiles have been built. Hsiung Feng 2 entered service in 1990 as a surface-to-surface ship-launched missile system, and is being offered for export. It is believed that 200 Hsiung Feng 2 missiles were planned for production. Reports in 1994 stated that coastal defence Hsiung Feng 2 missiles had also been deployed. The air-launched Hsiung Feng 2 version entered service in 1995. Two or three increased range Hsiung Feng 2 version missiles were reported to be in service in 2001, and an extended range version Hsiung Feng 2ER to be in development. A new mobile TEL vehicle was tested in May 2002, with a first missile launch. A ramjet-powered Hsiung Feng 3 version is in development, and flight trials started in 1998. The first live test against a sea target was made in July 2001, and production is expected to start in 2002. Hsiung Feng 3 is expected to enter service in 2003.

Specifications

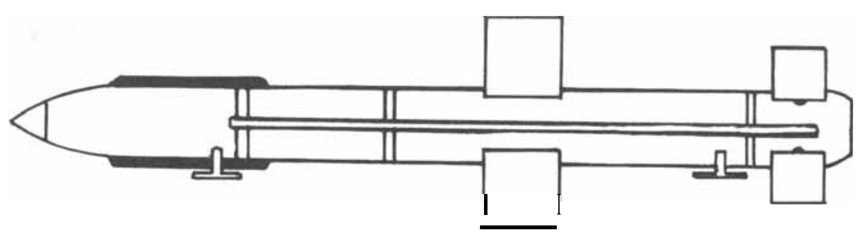
Hsiung Feng 1
Length: 3.42 m
Body diameter: 0.34 m
Launch weight: 522 kg
Payload: Single warhead; 180 kg
Warhead: HE semi-armour-piercing
Guidance: Autopilot and semi-active radar
Propulsion: Solid propellant
Range: 35 km
Accuracy: n/k

Hsiung Feng 2
Length: 4.6 m (SSM), 3.9 m (ASM), 6.25 m (2ER)
Body diameter: 0.34 m
Launch weight: 685 kg (SSM), 520 kg (ASM), 1,440 kg (2ER)
Payload: Single warhead; 225 kg
Warhead: HE semi-armour-piercing
Guidance: Inertial and active radar with IIR
Propulsion: Turbojet
Range: 80 km, 150 km, 600 km (2E), 1,250 km (2ER)
Accuracy: n/k

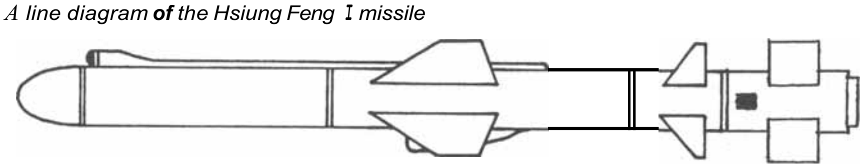
Hsiung Feng 3
Length: 6.25 m
Body diameter: 0.42 m
Launch weight: 1,500 kg
Payload: Single warhead, 225 kg
Warhead: HE or submunitions
Guidance: Inertial and active radar with IIR
Propulsion: Solid propellant boost and ramjet
Rnage: 300 to 600 km
Accuracy: n/k

Contractor

Chung Shan Institute of Research and Technology, Taipei.



A line diagram of the Hsiung Feng I missile



A line diagram of the Hsiung Feng 2 missile

PGM-500/-2000, Hakim (PGM-1/2/3/4)

Type
Short-range, air-launched, solid-propellant, single-warhead, air-to-surface missiles.

Development
The development of a family of guided bombs and air-to-surface missiles by ISC in the USA is believed to have started, on behalf of the United Arab Emirates, in 1984. Ferranti bought ISC in 1987, and then GEC-Marconi bought the Ferranti missile business in 1991. GEC-Marconi and Alenia Difesa merged their missile and other business divisions in 1998, with the new company known as Alenia Marconi Systems, and this became MBDA and part of EADS in 2001. The missile programme has been given several names over the years, but it is believed that the UAE knows the project as Hakim and that the designators are PGM-1 to 4 (Precision Guided Munitions). Other names that have been ascribed to this programme and its missiles include Project Alpha, GMX, Felix, Pegasus and Little Brother. In 1995, the Hakim family of missiles were renamed as PGM-500 and PGM-2000, depending on the warhead weight. The PGM-500 designator refers to all the missiles with a 500 lb (227 kg) warhead, and the PGM-2000 designator to the 2,000 lb (910 kg) warhead missiles.

Reports in 1995 indicated that there have been three alternative types of seeker developed for the PGM-500/-2000 family of missiles, Semi-Active Laser (SAL), *N*, and imaging IR, and these can be fitted to the two different sizes of missile. The missile designations are believed to be PGM-500/1 for SAL seekers, PGM-500/2 for *N* and PGM-500/3 for IIR seekers; and the same for the larger PGM-2000 missiles. The earlier designators were A for the PGM-500 version and B for the PGM-2000. The SAL and TV seeker versions are believed to have started production in 1990, and the IIR seeker version in 1993. A further version is reported to be in development, with a dual mode active and passive radar seeker, that may be retrofitted to earlier missiles.

PGM-500/-2000 missiles have been cleared for carriage on the Mirage 2000, Tornado, Jaguar, Harrier, F-16 Fighting Falcon, F/A-18 Hornet and F-4 Phantom aircraft. They have also been fit-checked on Hawk and F-5 Freedom Fighter aircraft. An unpowered version known as Lancelot, was proposed to the UK for a laser-guided bomb requirement in 1993, but was not selected and presumably has not been developed.

At the 1994 Farnborough Air Show, GEC-Marconi (now MBDA) displayed both PGM-500 and -2000 in public for the first time. They also displayed a full size model of the proposed Pegasus longer range standoff weapon for the first time. Pegasus, which looked similar to the rest of the PGM-500/-2000 family of missiles but with a turbofan engine in place of the rocket motors, was one of the contenders for the UK MoD's Conventional Armed Standoff Missile (CASOM) requirement. At the time it was believed that Pegasus was PGM-4, but in early 1995, new information indicated that the original Pegasus design specifications submitted to the UK government for clearance to sell the missile to the UAE were amended. The resultant missile proposal is now believed to have been PGM-4, and called Centaur. The Pegasus and Centaur programmes have been terminated.

A PGM-2000 missile, with two rocket motors under the rear body (Duncan Lennox)
0062327


A PGM-500 missile on display at the Farnborough Air Show in 2000 (Duncan Lennox)
0089989

Description
The current family of PGM-500/-2000, medium-range, air-to-surface missiles has two missiles with different sized warheads and solid propellant motors that can be fitted with either SAL, *N* or IIR seekers. The PGM-500/1/2/3 missiles have a constant diameter cylindrical body with a hard saddleback to hold the standard NATO 356 mm suspension lugs. The rear of the missile is fitted with four large clipped triangular wings with ailerons for directional control. These have a similar configuration to the AGM-142 Popeye missile, in that the wing span in the horizontal plane is greater than in the vertical. Some models have also been seen where the two upper wings are slightly shorter in length than the lower ones, which may be to provide an increased clearance for carriage on a particular aircraft. Between the lower two wings mounted externally on the bottom surface of the missile body, is a single 127 mm (5 in) MARC 223 solid propellant rocket motor developed by Atlantic Research Corporation. All three types of seeker have a glass rounded nose and a fixed clipped triangular horizontal stabilising fin on each side of the body just behind the nose.

The PGM-500 version missiles are 3.38 m long, have a body diameter of

0.36 m, have a horizontal wing span of 1.08 m and vertical one of 0.55 m. When fitted with a penetrating warhead and a MultiFunction Bomb Fuze (MFBF) they weigh 404 kg. The missiles have a maximum range of 15 km when launched from low level, and around 50 km when launched from medium level (30,000 ft).

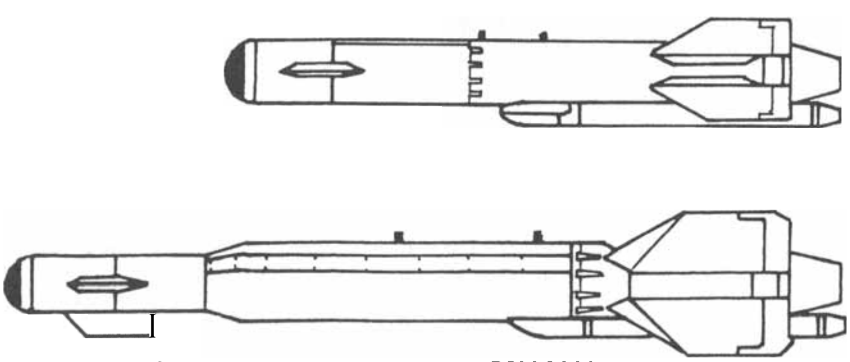
The PGM-2000 version missiles have the same basic configuration as the smaller PGM-500 missiles, except they have a larger diameter rear body section and the nose tapers to allow fitment of the same seeker assemblies. Also, they have two external 127 mm MARC 223 solid propellant rocket motors in parallel, instead of one, and an additional vertical stabilising fin is attached to the under surface of the seeker in line with the horizontal ones. The two rocket motors are fired sequentially on this version. The suspension lugs in this case are 762 mm apart.

PGM-2000 missiles are 4.62 m long, have a body diameter of 0.46 m, have a horizontal wing span of 1.52 m and vertical span of 0.77 m. When fitted with a penetrating warhead and a MultiFunction Bomb Fuze (MFBF) they weigh 1.115 kg, but with alternate warheads the weight is 1,060 kg. The PGM-2000 version missiles have a maximum range of 15 km when launched from low level, and a range of 50 km when launched from medium level (30,000 ft). As well as the penetrating warheads, which are reported to be simply steel pipes filled with HE, there are believed to be other options for each of the missiles, including blast/fragmentation and anti-armour and minelet submunitions. The submunitions are expected to be based upon the earlier 1960/70s ISC designs used in the US Rockeye Mk 6/7 dispenser systems. The semi-active laser-guided missiles, PGM-500/1 and PGM-2000/1, require the launch aircraft to carry a laser designation pod or another aircraft could designate the target, or the missile could be guided by a ground designator illuminating the target.

A PGM-2000 missile shown under the wing of a UK Tornado GR. Mk 1 aircraft. Note the tapered nose-section and the vertical stabilising fin beneath the seeker section (Alenia Marconi Systems)

PGM-500/2 and PGM-2000/2 missiles are TV-guided, and the PGM-500/3 and PGM-2000/3 missiles are imaging IR guided. For these missiles the launch aircraft would require a data link pod, and the missile would be fitted with a data link transceiver for the transfer of target information and reception of guidance commands. With the operator setting his target marker on the TV or IIR display screen to the selected target, the missile would then be guided automatically to the designated target. The data link pod has a length of 3.35 m, a body diameter of 0.35 m, and a weight of 280 kg. The pod has an antenna and radome at each end, and has a range of 100 km. All the missiles can be launched with target lock-on before or after launch.

The PGM-4 and Pegasus/Centaur proposals were variants of the PGM-500/-2000 (Hakim) design incorporating a turbojet engine to increase the range to over 250 km. These proposals are believed to have included inertial and GPS mid-course guidance with either an IR or a millimetric-wave radar terminal seeker.



Line diagrams of the Hakim PGM-500 (above) and PGM-2000 (below)

Operational status

Development of the family of weapons started around 1984, and it is believed that flight trials were carried out in France on Mirage 2000 and in the USA on F-16 aircraft. Hakim PGM-500/-2000 missiles (SAL and TV guided) are believed to have entered service with the UAE in 1992, for use on Mirage 2000 aircraft. PGM-500/3 and PGM-2000/3 (IIR guided) are believed to have started production in 1993 and to have entered service in 1995. Reports suggest that a total of around 1,750 PGM-500/-2000 missiles have been ordered by the UAE. There are no other known users of these missiles.

Specifications

PGM-500/1/2/3

Length: 3.38 m
Body diameter: 0.36 m
Launch weight: 404 kg
Payload: Single warhead
Warhead: 227 kg HE or submunitions
Guidance: Inertial and SAL or TV or IIR terminal
Propulsion: Solid propellant
Range: 50 km
Accuracy: n/k

PGM-2000/1/2/3

Length: 4.62 m
Body diameter: 0.46 m
Launch weight: 1,060 to 1,115 kg
Payload: Single warhead
Warhead: 910 kg HE or submunitions
Guidance: Inertial and SAL or TV or IIR terminal
Propulsion: Solid propellant
Range: 50 km
Accuracy: n/k

Contractor

MBDA Missile Systems, London

Sea Eagle

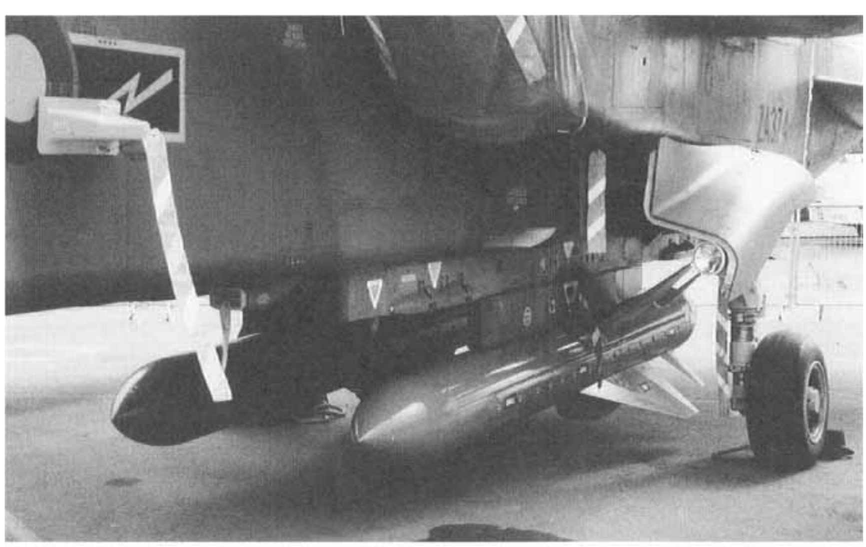
Type
Short-range, air-launched, turbojet-powered, single-warhead, air-to-surface missile.

Development
Sea Eagle design work started in 1977, when the project was known as P3T, to meet a requirement for an air-to-surface sea-skimming anti-ship missile to replace AJ-168 Martel TV. Full-scale development started in 1979 and evaluation trials started in 1984. Designed initially for carriage on the Buccaneer and Sea Harrier aircraft, the missile has also been cleared for carriage on the Tornado GR Mk 1B and Mk 4, and Jaguar aircraft. A helicopter-launched version with two externally mounted boost motors has been developed and cleared for use on Indian Sea King helicopters. A ship-launched version was developed by British Aerospace (now MBDA, part of EADS) as a private venture and tested in 1987, but this version has not been ordered. A mid-life update programme started in 1996 and was planned to give the missiles a 25-year life. A complementary warhead and safety arming unit replacement programme was planned for introduction into service in the UK starting in 2000, but the UK decided to take its Sea Eagle missiles out of service in 1999. Several variants were proposed for future requirements, including a missile called Golden Eagle with a 200 km range, an Imaging Infra-Red (IIR) seeker and a datalink. Reports in 1997 stated that initial carriage trials had been made in India to fit Sea Eagle missiles to Su-30MKI 'Flanker', Tu-142M 'Bear F' and Il-38 aircraft, but the integration programmes were not completed.

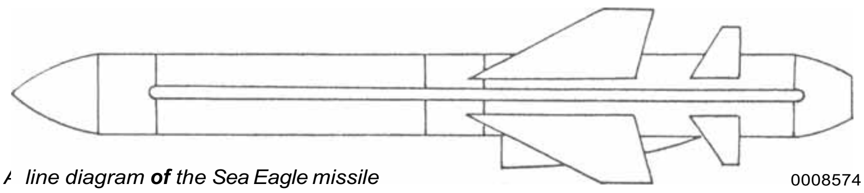
Description
The Sea Eagle missile uses a similar airframe to Martel, but has an underbody air inlet for the turbojet engine. The missile is 4.14 m long, has a body diameter of 0.4 m and a launch weight of 600 kg. Guidance is inertial for mid-course, followed by a X-band (8 to 10 GHz) active pulse radar terminal seeker with a range of 30 km and a re-programmable digital computer. A radar altimeter provides height control for the sea-skimming part of the trajectory. The missile flight control computer allows it to vary the attack height, fly random manoeuvres, overcome countermeasures and decoys and to attack from any direction. On long range flights, the missile can be programmed to climb at about 30 km from the target and use its active radar seeker to reconfirm the target's position, then descend again for a low level attack. A 230 kg HE semi-armour-piercing warhead is used with a delayed impact fuze to penetrate the target ship's hull before exploding inside. A Microturbo TRI-60-1 kerosene fuelled turbojet engine gives the missile a maximum range of 110 km. Sea Eagle has a cruise speed of M0.85. The missiles fitted to Sea King helicopters have two externally mounted solid propellant boost motors.

A Sea King helicopter launching a Sea Eagle missile in early trials 0008575

A Sea Harrier aircraft carrying two Sea Eagle missiles



Two Sea Eagle missiles carried under a Tornado GR Mk 1B, at Paris in 1995
(Duncan Lennox)



A line diagram **of** the Sea Eagle missile 0008574

Operational status

Sea Eagle entered service in the UK in 1985 and production was completed in 1992. The Buccaneer was taken out of service in 1994, and the Sea Eagle missiles transferred to the Tornado **GR.** Mk 1B and Mk 4 aircraft. The UK removed its remaining 255 missiles from operational service in April 1999. Exports of Sea Eagle have been made to Chile, India and Saudi Arabia.

Specifications

Length: 4.14 m
Body diameter: 0.4 m
Launch weight: 600 kg
Payload: Single warhead
Warhead: 230 kg HE semi-armour piercing
Guidance: Inertial with active radar
Propulsion: Turbojet
Range: 110 krn
Accuracy: n/k

Contractors

MBDA Missile Systems, London.

MGM-140 ATACMS (M39)

Type

Short-range, mobile ground-launched, solid-propellant, single-warhead ballistic missile.

Development

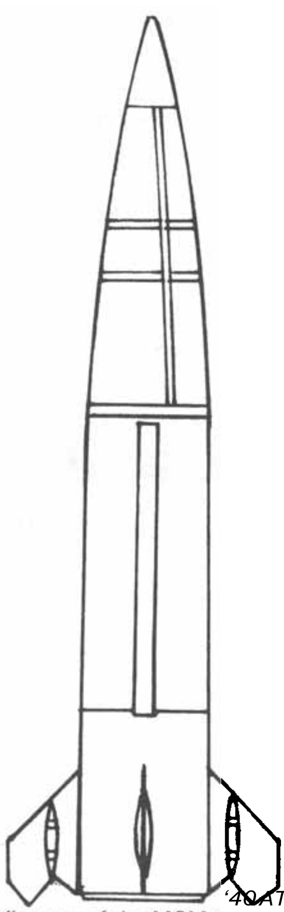
The beginning of the Army TACtical Missile System (ATACMS) development can be traced to the 'Assault Breaker' technology demonstration programme begun in 1978 by the US Defense Advanced Research Projects Agency. Formally started in 1983 as the Joint TACtical Missile System (JTACMS) programme, the project combined two earlier studies into a joint programme, the Army's Corps Support Weapon System and the Air Force Conventional Standoff Weapon.

Following the end of the USAF participation in 1985, the US Army continued the programme and changed the name to ATACMS. The development programme involved the improvement and modification of the Multiple Launch Rocket System (MLRS) launch vehicle to enable the launch of a larger missile, which was originally planned as a conventional HE replacement for the nuclear warhead version of the MGM-52 Lance. ATACMS has been designed to attack critical high value targets of rear echelon forces, including airfields, SAM sites and mobile SRBM launchers. There were five major versions being considered. MGM-140A Block 1 (M39) is the standard in-service missile that carries 950 submunitions out to a range of 165 km.

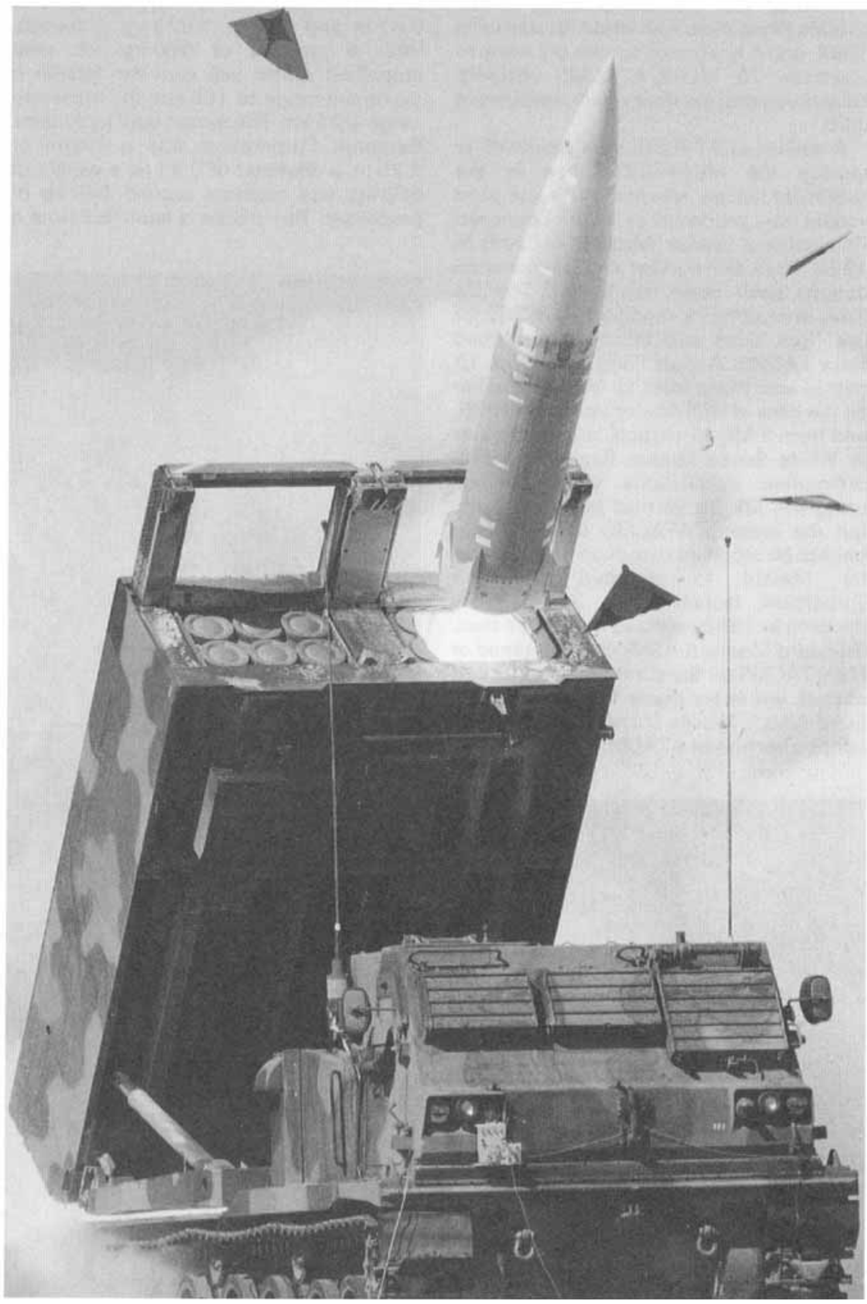
MGM-140B Block 1A (M39A1) carries 300 submunitions over a range extended to 300 km, but delivered more accurately than the shorter range Block 1 missiles.

MGM-140C Block 2 (M39A3) missiles will carry 13 BAT submunitions or BAT P31 improved submunitions, developed originally for the AGM/MGM-137 TSSAM programme, out to 145 km. The BAT P31 submunitions have been designed to attack both stationary and moving targets. MGM-140D Block 2A was planned to carry six BAT improved submunitions to 300 km, but this version was terminated in November 1999 due to US Army funding pressures.

The TACtical Missile System Penetrator (TACMS-P) uses ATACMS missiles to carry a hard target penetrating warhead, and this was originally known as the Block 3 missile. This development programme is being supported by the US Army and US Navy, and integrates a modified UGM-96 Trident C-4 SLBM Mk 4 re-entry vehicle containing a conventional HE warhead with the ATACMS Block 1A missile. The modified **RV** will have a guidance and control system fitted, to change the trajectory in space and following re-entry. Other warheads may be considered for this version, which is planned to have a



A line diagram of the MGM-1'40ATACMS Block I missile



An MGM-140 Army TACMS Block 1A missile being launched from the M270 MLRS launch ***vehicle*** (US Army)

0062326

maximum range of 300 km. A further design was considered, extending the range of the TACMS-P missile to nearly 500 km. Development started in 1999 for an interim unitary warhead version of the Block 1A missile, using the HE blast/ fragmentation warhead from the AGM/ RGM-84 Harpoon and SLAM missiles to replace the 300 submunitions. This version has a range of 270 km, and has been designed to minimise collateral damage and to attack critical point targets in all weather. Plans were reported in 1997 to modify some BAT submunitions with GPS and a TV camera, to be used for battlefield damage assessment. Trials in 1994 established the feasibility of a single ATACMS missile being carried and fired from the High-Mobility Artillery Rocket System (HIMARS) vehicle. The HIMARS will be fitted on a family of US Army medium tactical vehicles, with a weight of 13,000 kg and transportable by C-130 aircraft. Firing trials with HIMARS started in 1994, and it is planned for the US Army to purchase 75 MLRS/ATACMS HIMARS launch vehicles for their rapid deployment units.

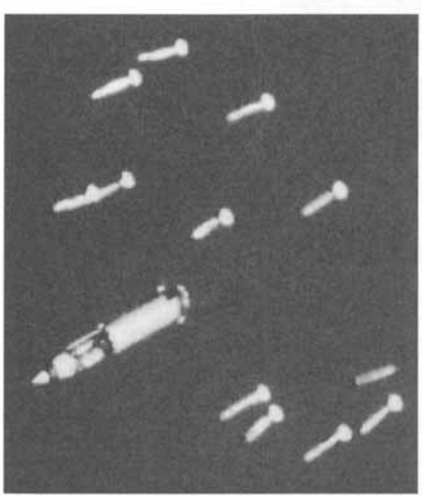
A variant of ATACMS was proposed to replace the MGM-52C Lance in the battlefield nuclear role and an air-launched variant was proposed as an Air-Launched Conventional Attack Missile (ALCAM) in 1991. Both the nuclear and air-launched options have been terminated. The US Navy considered a modified ATACMS for use from ships and submarines, named Navy TACMS. A trials firing of a Block 1A missile was made from an M270 launcher on the deck of USS *Mount Vernon* in 1995, and from a Mk 41 vertical launch canister at White Sands Missile Range in 1996. Submarine installations were planned using the Mk 36 vertical launch system, but the existing ATACMS design would have to be modified to reduce the diameter for fitment to standard UGM-109 Tomahawk launch tubes. A US Navy decision in 1998 selected the Land Attack Standard Missile (LASM) option instead of Navy TACMS for the short term, but further studies are to be made for an Advanced Land Attack Missile (ALAM) which might adopt a version of ATACMS.

In March 2002 it was reported that ATACMS was being considered by the US Navy for fitting to converted 'Ohio' class submarines, when they are modified to the SSGN role. The US Army and the prime contractor, Lockheed Martin Missiles and Fire Control, are planning a joint programme to develop a lower unit production cost for ATACMS, and this is known as TACMS 2000, which has the objective of reducing the cost by 30 per cent.

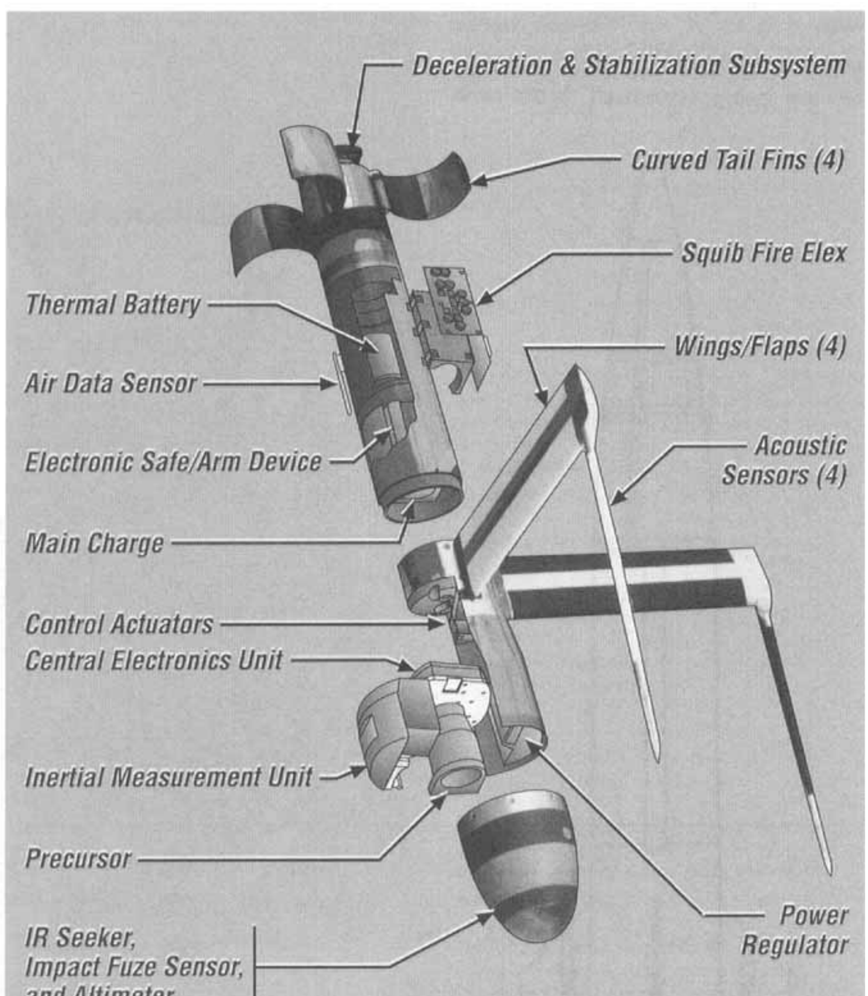
Description

The MGM-140 ATACMS Block 1 missile is similar in design and shape to the MGM-52 Lance tactical missile. The main difference is that Lance used liquid propellants, and ATACMS uses a solid propellant motor. Flight control is achieved by four folding, swept rectangular clipped fins at the rear, which are extended at launch. The missile is 3.98 m long, has a body diameter of 0.61 m and weighs 1,673 kg at launch. With a payload of 560 kg, its solid propellant motor will give the missile a maximum range of 165 km, the minimum range is 25 km. The motor, built by Atlantic Research Corporation, has a length of 2.25 m, a diameter of 0.61 m, a weight of 800 kg, and contains around 640 kg of propellant. The missile is launched from a modified version of the MLRS M270 AVMRL (Armoured Vehicle Multiple Rocket Launcher). The missile is packaged in a launch pod similar in size to that used for six MLRS rockets, with only two ATACMS carried per launcher vehicle. The M270 launch vehicle carries a crew of three, is 6.98 m long, 2.97 m wide and weighs around 25,000 kg loaded. A 500 HP turbo-diesel engine gives the vehicle an un-refueled range of 500 km, and a maximum road speed of 65 km/h. An improved version of the M270 launcher, designated M270A1, will be used for the ATACMS Block 1A and later missile versions, to provide GPS initialising data for the missiles. In addition, these launchers will have a new fire-control system, provide for faster missile reloading, and give a shorter response time to launch requests. ATACMS Block 1, Block 1A and Block 2 missiles have also been launched from a new US Army HIMARS XM 142 wheeled vehicle, which is C-130 Hercules transportable and carries either six MLRS or one ATACMS. The HIMARS vehicle is based on the 5-ton medium tactical vehicle for use by US rapid reaction forces.

Block 1 ATACMS has an inertial guidance system. Block 1A, Block 2 and TACMS-P missiles will incorporate a GPS receiver for in-flight position updates.



A Block 2 missile just after dispensing the BAT submunitions during a flight trial in 1998 (US Army) 0062323

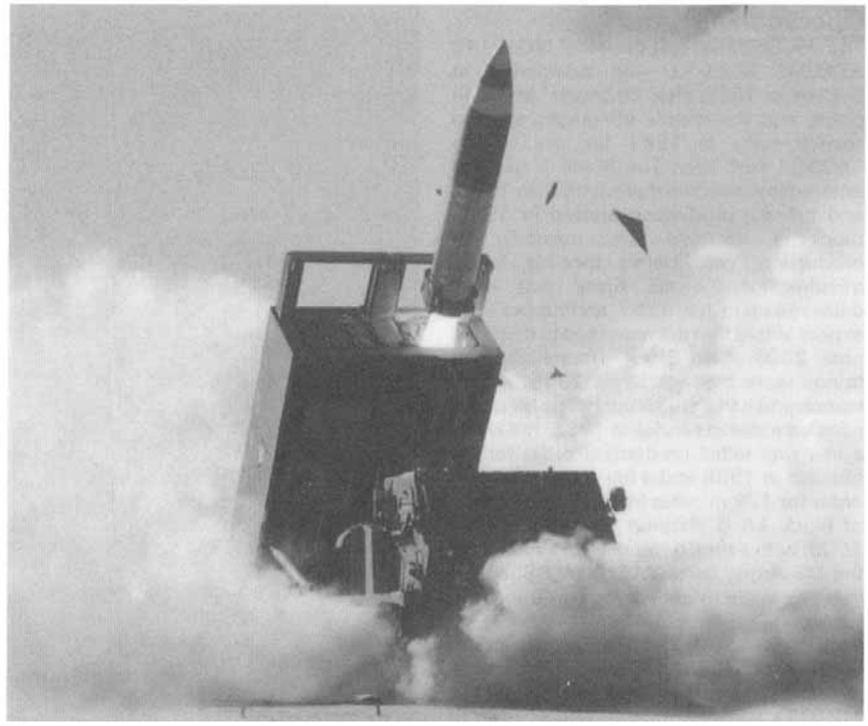


An exploded view of a BAT submunition, showing the major assemblies (Northrop Grumman) 0008578

On arrival at the target the submunitions are dispensed from the warhead. The ATACMS Block 1 Anti-Personnel/Anti-Materiel (APAM) warhead carries 950 M74 bomblets and weighs 560 kg. Each M74 bomblet is 0.06 m in diameter and weighs 0.59 kg. The M74 has a shaped HE charge surrounded by a tungsten fragmenting wall and a steel casing and two incendiary pellets. The Block 1A (ER-ATACMS) has the same dimensions at the Block 1 missile, but has a launch weight reduced to 1,321 kg. The Block 1A missile has a 160 kg payload of 300 M74 bomblets, but has an improved INS/GPS guidance system and a range extended to 300 km. The minimum range is 100 km. A Block 1A unitary warhead version has been developed and tested, and this version exchanges the submunitions warhead assembly for either a 213 kg HE blast/fragmentation WDU-18B warhead used with the AGM/RGM-Harpoon and SLAM missiles, or the 247 kg WDU-40/B HE blast penetration warhead used with the SLAM-ER missile. The maximum range of this version is 270 km.

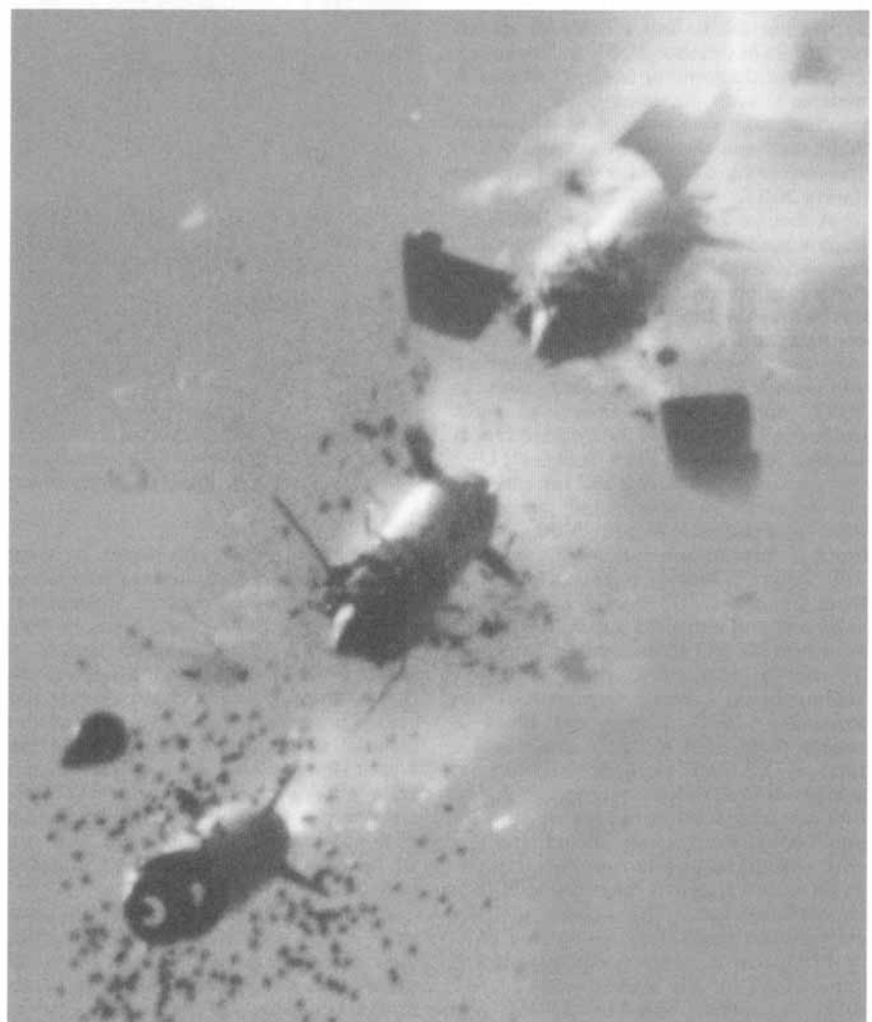
The Block 2 ATACMS missile has the same dimensions and shape as the Block 1 missiles, but has a launch weight of 1,483 kg and a payload of 268 kg. The missile warheads will carry terminally guided submunitions effective against moving armour or stationary missile launch vehicles. The initial Block 2 payload design has 13 Northrop Grumman BAT submunitions, but later Block 2 missiles may have improved P31 BAT submunitions. The present BAT submunition is 0.90 m long, has a body diameter of 0.14 m, has an unfolded wing span of 0.91 m and a weight of 20 kg. Each BAT has four acoustic sensors on the wing tips, and a dual colour IR sensor in the nose, to autonomously seek, acquire, identify and then attack selected moving armoured vehicles. The BAT submunitions are dispensed at supersonic speed from the missile as it approaches the target, by inflating gas bags located at the centre of the payload bay. The submunitions are then slowed by a stabiliser chute at the rear of each BAT, which is jettisoned when the speed has been reduced sufficiently. The BAT submunition has a tandem shaped charge HE warhead. Later versions of BAT (improved P31 BAT) are planned to have dual-mode MMW active radar and imaging IR seekers, together with the acoustic sensors, so that they can select both moving and stationary targets. The P31 BAT submunitions will also have improved ECCM and IRCCM, and a dual-mode warhead, selectable for use against armoured or soft targets. It is believed that the Block 2 ATACMS will have a minimum range of 35 km and a maximum range of 140 km.

The TACMS-P version is being developed as a demonstrator using a Mk 4 re-entry vehicle with an HE penetrating warhead attached to a Block 1A standard missile. The warhead or RV weight is estimated at 220 kg, with the penetrator warhead assembly weighing 120 kg. TACMS-P will use INS/GPS guidance within the RV to correct the trajectory in space, as well as following re-entry into the atmosphere. This version is expected to have a range of around 250 km.



The launch of an MGM-140ATACMS Block 2 missile in October 1997 (US Army)

0038270



A dispense sequence (from top right to bottom left) for a Block IA missile, showing the release of the 300 M74 bomblets (Lockheed Martin)

0062325

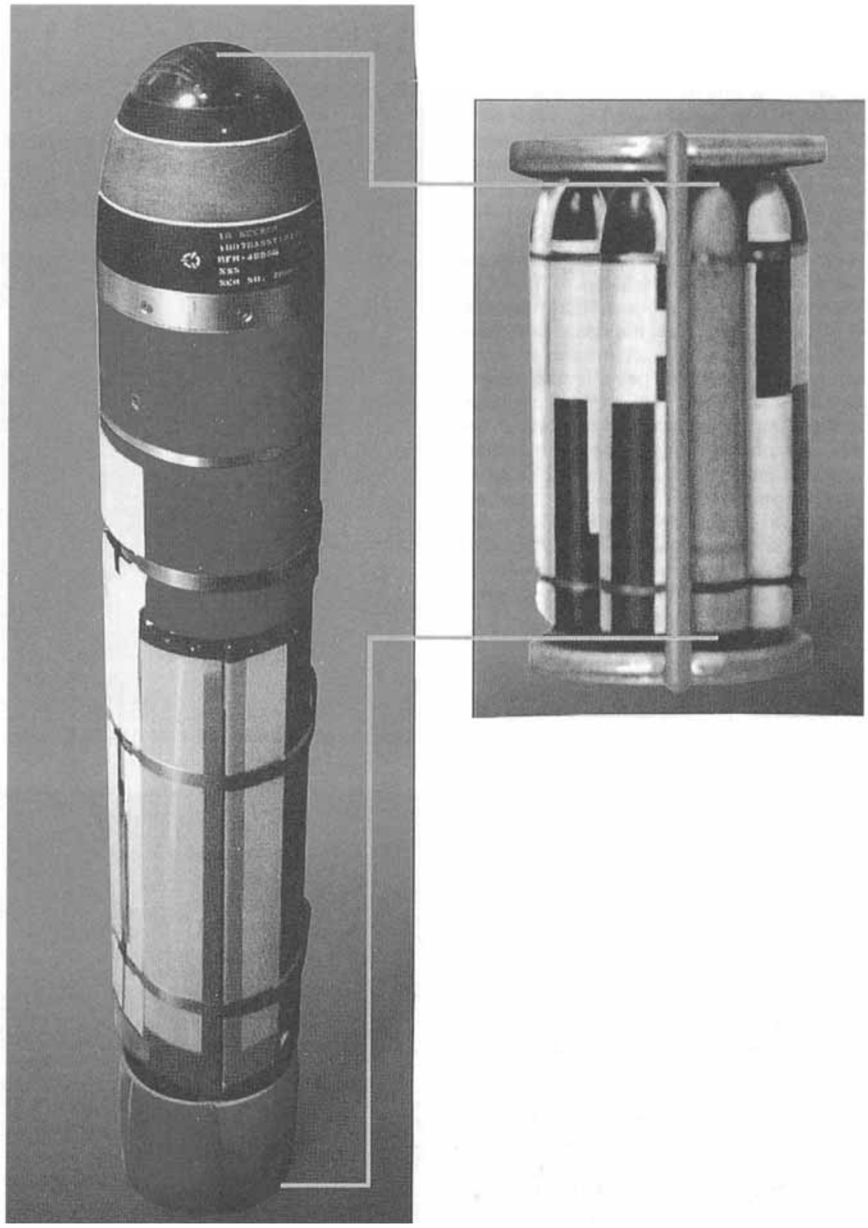
Operational status

The development test phase of MGM-140 ATACMS Block 1 was completed in December 1989, after 25 firings had taken place, and the missile effectively entered service early in 1991 for use in the 1990-91 Gulf War. The Block 1 missiles entered low-rate initial production in 1988, and full-rate production started in 1991. Block 1 missiles are currently in production, with orders totaling 1,647 missiles for the US Army that were delivered up to July 1997, and further FMS export orders that are expected to continue until 2003. Two Block 1A missile test firings were made early in 1995, a land launch and a trial ship launch. The Block 1A missiles entered service in 1998, following a low rate initial production order for 70 missiles in 1996 and a full rate production order for 179 missiles in 1998. Production of Block 1A is planned to continue until 2003, with a total order of 625 missiles for the US Army. Some M270 MLRS launch vehicles were modified with an improved positioning system, so that they could be used to launch Block 1A missiles until the upgraded M270A1 vehicles became available. Low-rate initial production for the M270A1 started in 1998, and the fourth LRIP contract was placed in February 2001. Two Block 1A missiles were launched from a M270A1 launchvehicle in September 2000, and a HIMARS launch was made in October 2001. In November 2000, the US Army ordered 43 Block 1A missiles with unitary HE blast/ fragmentation warheads, and a 140 km flight test was completed in April 2001. The remaining 42 missiles were delivered during 2001.

A further 24 missiles with HE blast/ fragmentation warheads were ordered in February 2002. It is believed that the US Army may convert some existing Block 1 missiles to the Block 1A unitary warhead configuration.

Block 2 missiles have been developed, and following eight successful trials in 1997 and 1998 a low-rate initial production order (LRIP) was placed for 24 missiles in February 1999. A second LRIP was placed in February 2000 for a further 45 missiles. Six operational evaluation flight tests started in August 2000, and the Block 2 missiles entered service in early 2002. The US Army is planning for 1,206 Block 2 missiles, 400 Block 2 with 13 BAT submunitions and 806 Block 2 with 13 improved P31 BAT submunitions. The Block 2A missile programme, with six P31 BAT submunitions, was terminated in November 1999. During the Block 2 missile flight trials in 1997 and 1998 a total of 23 BAT were flown, with an additional 42 simulated submunitions. The BAT were dispensed at ranges between 42 and 140 km from launch, including a test with a deliberate position error at dispense, and a launch against a target using IR flare countermeasures. The baseline BAT submunition programme completed EMD in 1997, and a contract was awarded in June 1998 for 89 missile loads (1,157 BAT) for initial operational test and evaluation. A second LRIP order for 609 BAT was placed in early 2000.

The P31 BAT programme is in demonstration and validation, with two captive carry trials completed in early 1998, and engineering and manufacturing development started in 2000. The first test flight for the P31 BAT was made in April 2001, and a 12 flight series started in March 2002 with a re-useable test vehicle that is dropped from a light aircraft and lands on a parachute after over flying the planned target. Three test flights of the TACMS-P version with a penetrating warhead are planned to start in 2003, engineering and manufacturing development may start in 2005, with the US Army planning to procure 332 missiles from 2007.



A BAT submunition in its folded configuration (left), with the 13 submunitions inside the ATACMS Block 2 warhead bay (right) (Northrop Grumman) 0008577

Lockheed Martin was awarded a three-year EMD contract for the HIMARS launcher in January 2000, including six vehicles for evaluation. HIMARS deliveries to the US Army are planned to start in 2004.

It was reported that 32 ATACMS were fired during the 1990-91 Gulf War against Iraqi missile sites, logistics areas, artillery and rocket battery positions. Real-time target information was supplied by E-8 Joint STARS aircraft using synthetic aperture radar surveillance systems. Export orders for ATACMS Block 1 missiles have been made by Bahrain (30), Greece (71). South Korea (290) and Turkey (120). Greece ordered more missiles in 1999, and South Korea requested 110 Block 1A missiles in December 1999.

Specifications

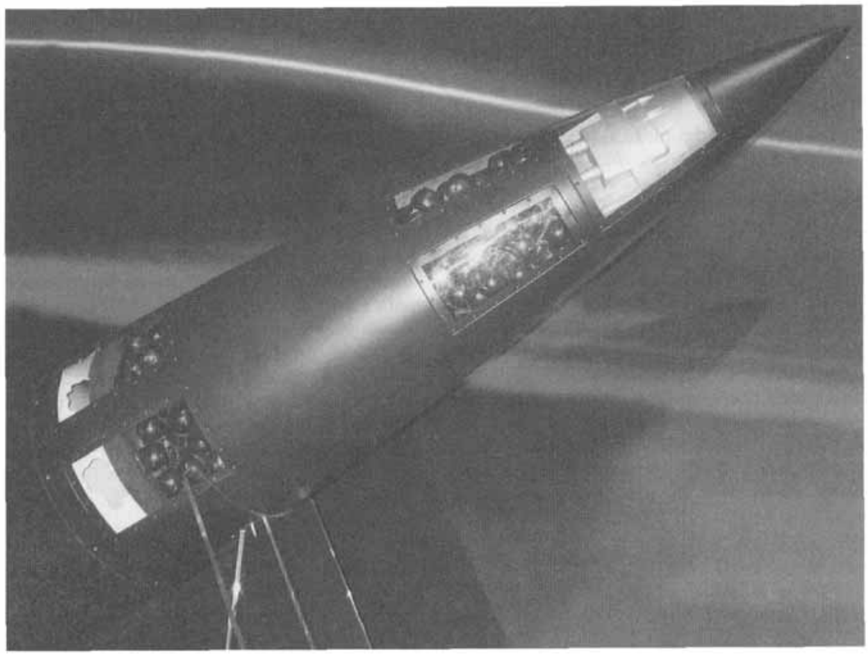
Block 1
Length: 3.98 m
Body diameter: 0.61 m
Launch weight: 1,673 kg
Payload: Single warhead; 560 kg
Warhead: Submunitions (950 × M74 bomblets)
Guidance: Inertial
Propulsion: Solid propellant
Range: 165 km
Accuracy: n/k

Block 1A
Length: 3.98 m
Body diameter: 0.61 m
Launch weight: 1.32 1 kg
Payload: Single warhead; 160 kg or 213 kg (unitary)
Warhead: Submunitions (300 × M74 bomblets) or HE blast/fragmentation (unitary)
Guidance: Inertial with GPS
Propulsion: Solid propellant
Range: 300 km or 270 km (unitary)
Accuracy: n/k

Block 2
Length: 3.98 m
Body diameter: 0.61 m
Launch weight: 1,483 kg
Payload: Single warhead; 268 kg
Warhead: 13 BAT submunitions
Guidance: Inertial with GPS
Propulsion: Solid propellant
Range: 140 km
Accuracy: n/k

Contractors

Lockheed Martin Missiles and Fire Control, Dallas, Texas (missile).
Northrop Grumman, Hawthorne, California (BAT submunition).



An Army TACMS Block 1 missile warhead assembly, showing the spherical M74 bomblets (Duncan Lennox) 0062324

MGM-52 Lance

Type
Short-range, road-mobile, liquid-propellant, single-warhead ballistic missile.

Development
The MGM-52 Lance was developed to replace the Honest John and Sergeant missiles, the first testing beginning in 1965. Lance entered service in the USA in 1972, and production ended in 1980. There were two versions in service in 1990, the MGM-52B and MGM-52C. It is clear that there will be no direct nuclear warhead Lance successor, as the AGM-131 SRAM-T programme was terminated in 1991, and the role has now been taken over by the conventional HE warhead MGM-140 ATACMS.

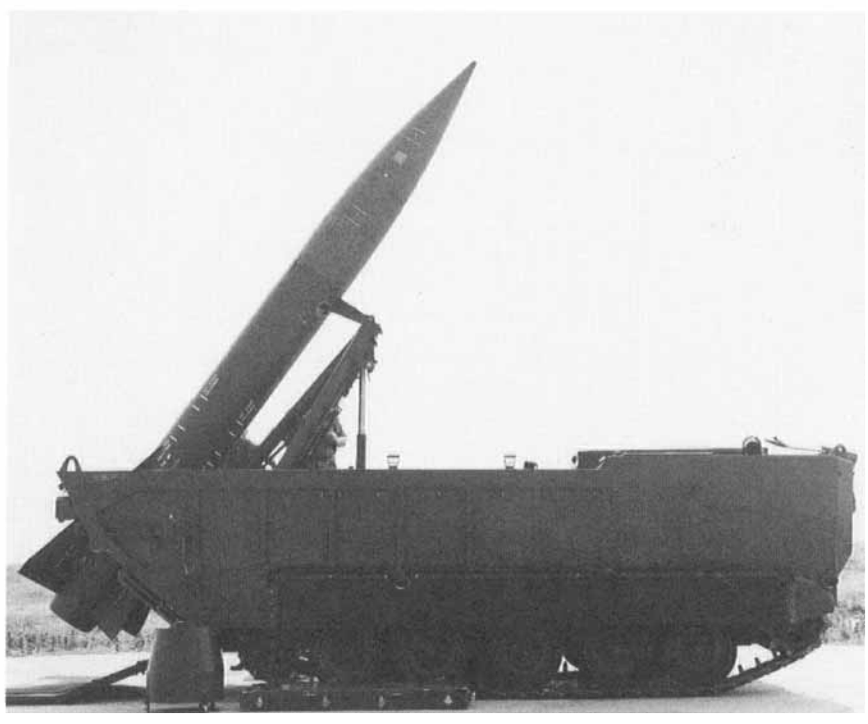
Description
Lance is a short-range ballistic missile, 6.41 m long and 0.56 m in diameter. It has a launch weight of 1,527 kg and a range of 130 km. It utilises storable liquid propellants and a simplified inertial guidance system. The missile is spin-stabilised in flight to improve accuracy. The warhead can be either 270 kg HE, which can include unitary HE or cluster type submunitions, or a W70 nuclear warhead, with selectable yields in the 100 kT range. There was also an option of an enhanced radiation type of nuclear warhead, the W70-3, which became available in 1982, but this was only available to US forces. The missile is carried on a tracked M752 TEL. with two reloads carried on a second vehicle.

The distinctive smoke trail from the launch of an MGM-52 Lance missile

Operational status
The Lance missile first entered service in the USA in 1972 and was extensively deployed in NATO Europe, with some missiles also being based in South Korea. Exports were made to Belgium, Germany, Iran, Israel, Italy, Netherlands and UK. It was reported in 1990 that there were 90 Lance launchers in western Europe, with 300 conventional HE warheads and 700 nuclear warheads available, and by the end of 1993 all the nuclear warheads had been withdrawn and stored in the USA. A further 150 nuclear warheads had been retained in the USA, making a total of 850 nuclear warheads, and it is believed that these have all been destroyed by the USA. MGM-52 Lance was withdrawn from service in NATO countries over the period 1991 to 1994 and several have been used as targets for ballistic missile intercepts by HAWK and Patriot air defence systems. It is believed that Iran and Israel have retained some of their Lance missiles, and that these remain available for operational use.

Specifications
Length: 6.41 m
Body diameter: 0.56 m
Launch weight: 1,527 kg
Payload: Single warhead
Warheads: Conventional HE (unitary and submunitions), W70 100 kT nuclear, or enhanced radiation nuclear W70-3.
Guidance: Inertial
Propulsion: Single-stage liquid propellant
Range: 130 km
Accuracy: 150 m CEP

Contractor
Lockheed Martin Missiles and Fire Control, Dallas, Texas (prime contractor).



An MGM-52 Lance missile on an M752 launcher vehicle ready to fire

LGM-30G Minuteman III

Type

Inter-continental-range, silo-based, solid-propellant, MIRV-capable ballistic missile.

Development

The LGM-30G Minuteman III development programme started in 1966 and the missile included several improvements that distinguish it from Minuteman II, mainly related to the final stage and re-entry system. The third stage was improved by the introduction of a new motor using fluid injection TVC, which provided a finer control than the previous system of four movable nozzles. The MIRV platform is essentially a fourth stage, but is not usually referred to as such because, by the terms of the SALT 2 Treaty, a Post Boost Vehicle (PBV) must not be capable of giving the payload an additional velocity increment of more than 1,000 m/s, thus distinguishing it from a normal booster stage. The PBV is manoeuvred by six pitch and yaw motors, and four smaller roll motors. The guidance system for the PBV also controls the RV and penetration aid releases.

The Mk 12 RVs on the earlier versions of this missile have been replaced with the Mk 12A RVs; this RV is 16 kg heavier than its predecessor, slightly reducing the range and footprint of the system. These two sets of improvements enabled the missile to achieve a greater range through better energy management, and improve the accuracy to a CEP of less than 200 m. This figure was further improved by the retrofitting of the Advanced Inertial Measurement System (AIMS), developed for the MX (LGM-118 Peacekeeper) missile, which has provided an accuracy reported as 120 m CEP.

The Minuteman silos were upgraded in the early 1980s. against the continual improvements in Russian missile accuracy and a further hardening programme for both the Minuteman III and Peacekeeper missile silos was started in 1990. Improvements were made to both blast hardness and resistance to electromagnetic pulses. The fleet of transporter-erector-vehicles was also replaced. A Minuteman extended survival power system improved the launch facility survival period by its greater resistance to nuclear radiation during conflict. It introduced high-energy lithium batteries, which commenced installation at the Minuteman silos in 1984. Most of the electrical equipment at the Minuteman silos has been redesigned to support the Peacekeeper missile, including new transmitters for communications with the Airborne Launch Control Centre (ALCC).

Following several strategic arms reduction proposals in 1991, the USA offered to download the Minuteman III missiles from three warheads to one and this was agreed during the START 2 discussions in 1992. The implications of this are that Minuteman III missiles will be retained in service now until 2020, and several modification programmes to the guidance and propulsion systems were started in 1993. TRW was appointed as prime contractor for the complete upgrade programme in 1997.

An early model of the Minuteman III front-end section, showing the three Mk 12 re-entry vehicles (Duncan Lennox)

A Guidance Replacement Programme (GRP) includes new electronics and computers for the missiles, improved power supplies and new test and support equipment. The IMU was not upgraded. The first flight test of the Boeing/Honeywell new guidance system was made in June 1998, and a second test was made in September 1998. A launch control centre modification programme was completed in 1996, and these have now been upgraded to include a Rapid Execution and Combat Targeting (REACT) capability. A further upgrade to the 50 launch control centres started in design and development in June 2002.

A Propulsion Replacement Programme (PRP) was started in 1994, to examine options for upgrading the three solid motor stages, and the first trials motors were tested in 1997. A joint team of Thiokol and Pratt and Whitney Chemical Systems Division are to replace the motors for stages one, two and three, and the first test launch using the new motors was made in November 1999. The PBV liquid propulsion system will also be upgraded, but in a separate programme. A warhead update programme examined two options for the downloading to one warhead per

missile; the first would use existing Mk 12 or Mk 12A re-entry vehicles from Minuteman III, and the second option would use Mk 21 RVs with 500 kT W87 nuclear warheads taken from LGM-118 Peacekeeper missiles as they are taken out of service.

A Safety Enhanced Re-entry Vehicle (SERV) programme was started in March 2002 to fit improved Mk 21 RVs with W87 warheads to 200 Minuteman III missiles, replacing the older W62 warheads.

Description

The Minuteman III is a three-stage, solid propellant ballistic missile, 18.2 m long and 1.85 m in base diameter. The launch weight is 34,467 kg and the maximum range is 13,000 km with the three RV payload. The minimum range is believed to be around 3,000 km. The second stage motors have a length of 4.1 1m, a diameter of 1.32 m and a launch weight of 7,202 kg. The solid propellant contained in the second stage motors weighs 6,248 kg. The NS-20 guidance system is inertial, and with the AIMS upgrade the accuracy has been improved to 120 m CEP. The upgraded guidance system is the NS-50, and this is reported to have the same accuracy requirement as the earlier system. The PBV carries up to three Mk 12 or Mk 12A re-entry vehicles plus a penetration aid package, which includes chaff and decoys. It is believed that some missiles may carry one, two or three warheads, although under START counting rules every missile is reported as having three warheads. The nuclear warheads in the Mk 12 RV are W62 with a yield of 170 kT each. The W62 warhead has a weight of 340 kg. The nuclear warheads in the Mk 12A RVs are the W78, with a yield of 335 to 350 kT each. The W78 warhead has a weight of 365 kg. The Mk 12A RV has a length of 1.81 m and a base diameter of 0.54 m. It has been reported that some Minuteman III missiles have been downloaded to one Mk 21 RV, taken from LGM-118 Peacekeeper missiles. The Mk 21 RV has a W87 nuclear warhead with a yield of 300 to 475 kT, and has a length of 1.75 m and a base diameter of 0.55 m. If the Mk 21 RV is fitted, then the accuracy may have been improved. The throw weight of Minuteman III was declared as 1,150 kg by the USA in 1991.

Modernisation of the launch control facilities since 1991 has included provision for rapid missile targeting, following the joint Russian/US agreement not to target each other's countries. Each launch control centre manages 10 missile silos, with two launch crew operators sitting side-by-side in the cylindrical underground capsules.

A Minuteman III missile launched from Cape Kennedy in 1969

Operational status

The Minuteman system has served as the mainstay of the US land-based strategic nuclear force since 1962; the system upgrades through the Minuteman II and III bringing the force to a maximum of 1,000 missiles in the early 1980s. The Minuteman III missiles entered operational service in 1970 and the force totaled some 550 missiles for many years until the introduction of the LGM-118 Peacekeeper missile system began in 1986. In 1993, there were reported to be 529 missiles, with a further 45 non-operational missiles believed to be available.

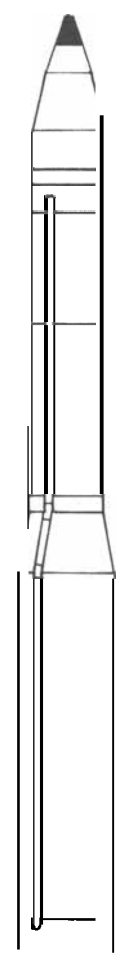
In 1993, the US DoD proposed to maintain the Minuteman III force by reducing the annual flight tests from seven missiles to four. Minuteman III missiles are deployed at Malmstrom (200). Minot (150). and F E Warren (150) AFBs. Minuteman II silos were vacated and refurbished at Malmstrom, with Minuteman III missiles transferred from Grand Forks AFB. The 150 missiles at F E Warren AFB were downloaded to one W62 warhead by August 2001, and these are planned to be replaced with single Mk 21 RVs with W87 warheads by 2009. The remaining missiles have a mixture of one, two or three RVs, but the plan is for a further 50 missiles at Malmstrom to be fitted with a single Mk21 RV and W87 warhead, also by 2009. The remaining 300 missiles will be downloaded to a single Mk 12A RV with a W78 warhead. The missile and system lives are being extended until 2020, with 500 operational silos and one silo retained at Grand Forks AFB as a museum. The first flight test of a single RV Minuteman III missile was carried out in February 1995, the first ground tests of replacement first-, second- and third-stage solid propellant motors were made in 1997, and the first flight test of the guidance replacement programme was made in June 1998. Limited initial production was authorised for 40 new guidance sets in 1998, and full production for a total of 652 sets at around 65 sets per year started in 2000. The first of the upgraded missiles was flight tested in November 1999, with four tests in 2000 and two in 2001. The upgrade programmes are due for completion by 2008.

Specifications

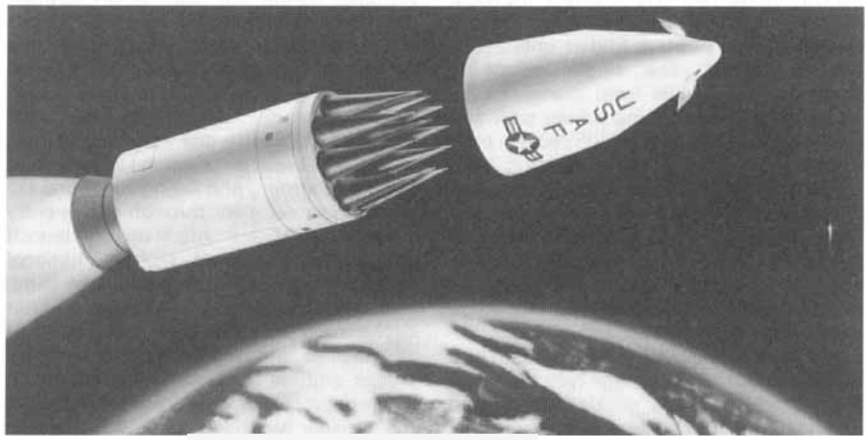
Length: 18.2 m
Base diameter: 1.85 m
Launch weight: 34.467 kg
Payload: Up to 3 Mk 12 or 12A RVs on PBV plus penetration aids
Warhead: W62 at 170 kT or W78 at 335 to 350 kT nuclear each
Guidance: Inertial
Propulsion: 3-stage solid propellant
Range: 13,000 km
Accuracy: 120 m CEP

Contractor

The US Air Force did not usually appoint a prime contractor for its weapons systems, the preference being to have major system and integration contractors, with the final responsibilities for the system being taken by the service itself. Boeing was appointed the co-ordinating contractor for the original Minuteman III programme. The prime contractor for the Minuteman III missile upgrade programme is TRW Strategic Systems Division.



LGM-118 Peacekeeper



An artist's impression of the PBV with 10 re-entry vehicles and the supporting nose shroud being removed in space (Textron Defense)

Type

Inter-continental-range, silo-based, solid-propellant, MIRV-capable ballistic missile.

Development

LGM-118A Peacekeeper, the former MX missile, was the result of a requirement for a new Inter-Continental Ballistic Missile (ICBM), first stated in 1972. Primarily, the new missile was to have improved accuracy, to maintain the capability against the upgraded Soviet missile silos, be survivably based, and to have more re-entry vehicles to handle the rapidly increasing number of hardened targets. Full-scale development began in 1979, with the first flight test in May 1983; but the controversy over the basing of the missile resulted in a considerable slowing of the programme. The missile was originally designed to have a Multiple Protective Shelter (MPS) basing system, then it was proposed to locate the missiles in Minuteman silos, and finally to establish a 'dense pack' in very hard silos. All three proposals were rejected by Congress and the Scowcraft Commission was tasked in 1983 to study the options again. This recommended a three-step approach: siting 100 missiles in existing Minuteman silos; investigation of the basing options; and the development of a less vulnerable, mobile missile, the Small ICBM (SICBM), known as XMGM-134 Midgetman. With the exception of a reduction by Congress of the fixed-based number from 100 to 50 missiles, this programme was agreed in 1984.

In April 1988, authorisation for development of a rail garrison basing was given, originally with an additional 50 missiles, but this decision was changed in 1989 to relocate the first 50 silo-based missiles onto railcars. The rail mobile missiles were to be designated MGM-118A. The railcar option was finally cancelled in 1991. Development on a new re-entry vehicle for the Peacekeeper missile began in 1977 as a separate programme. Called the Mk 21 Advanced Ballistic Re-entry Vehicle (ABRV) it was to replace the Mk 12A RV. The Mk 21 was designed to be more accurate, flexible and effective. Improvements incorporated in the Mk 21 included a jam-resistant warhead fuze and a newly designed nose tip to maintain the RV's aerodynamic shape during re-entry. The first three Mk 21 flight tests were successfully completed between 1979 and 1980. Full scale development of the Mk 21 was begun by Textron Defense Systems (formerly Avco Systems Division) in 1982, and later that year the development of the Mk 21 RV was incorporated into the Peacekeeper development programme.

The Minuteman silos and ground support facilities were upgraded to receive the Peacekeeper missile. The silos were modified by the removal of the upper 2 m of silo liner to allow on site assembly of the missile stages and re-entry system. The missile was the first US ICBM to be contained in a canister throughout its pre-launch lifetime and the canistered missile is supported in the silo by a shock isolation system that provides greater protection from ground shock.

Following the START 2 agreement in January 1993, it was determined that only single RV ground-launched ICBM would be retained after 2003, and that LGM-118 Peacekeeper missiles would be removed from operational service. START 2 was not ratified, and was overtaken by the SORT in May 2002. The USA will continue to remove Peacekeeper missiles from service, and some Mk 21 RV will be upgraded and used in the Minuteman III improvement programme.

In 1995, the US DoD authorised E'Prime Aerospace to develop a variant of the Peacekeeper missile as a satellite launch vehicle, with a USAF liaison office to monitor compliance with the relevant treaties, but it is believed that this programme was terminated in 1998. However, in 2002 it was announced that some Peacekeeper motor assemblies would be used to launch satellites, or as research vehicles and targets.

Description

LGM-118 Peacekeeper is a three-stage, solid-propelled, inter-continental range, MIRV capable ballistic missile. It is 21.8 m long, has a cone-shaped nose, a constant body diameter of 2.3 m, weighs 87,750 kg at launch and is credited with a range of 9,600 km. The Peacekeeper was the first US ICBM to use 'cold launching'; the procedure by which the missile is ejected from its launch container by a cold gas generator, which propels the missile some 20 to 30 m high, at which point the first-stage solid propellant motor ignites. The principle advantage of this system, long utilised by the Russians, is to reduce damage to the silo on launch, thus making refurbishment and reuse easier to achieve.

The Peacekeeper missile consists of a propellant system, post-boost system and a re-entry system. The propellant system has three stages; the first stage is 9.14 m long, weighs 48,948 kg and will boost the missile to about 23 km altitude. The first stage motor has 44,625 kg of HTPB propellant, and burns for 55.7 seconds. It is equipped with a single flexible movable nozzle, which is controlled by signals from the guidance and control system situated in the post-boost section. The nozzle movement is powered by a separate solid propellant gas generator. The second stage, which is 5.5 m long and weighs


A Peacekeeper missile lifts off from Vandenberg AFB on its 13th test flight

approximately 27,000 kg, ignites after the burnout and release of stage one, and propels the missile to an altitude of around 90 km. Stage two has a single movable nozzle which incorporates an extendable exit cone. The cone is folded until stage two is ignited. The single nozzle is controlled by signals from the guidance and control system using power provided by hydraulic actuators, which receive high pressure gas from a gas generator. Both stages one and two use a solid propellant with aluminium and oxidiser additives. The third stage, weighing about 7,700 kg, is 2.44 m long. The solid rocket motor ignites after burnout and release of stage two and boosts the missile to about 215 km. Stage three uses a synthetic polymer plastic-based solid propellant with aluminium and oxidiser additives. Like stage two, the stage three single movable nozzle also has an extendable exit cone and is controlled in the same manner. The solid propellants in the first three stages are contained in motor cases made of Kevlar epoxy material. The fourth stage, also known as the Post-Boost Vehicle (PBV), weighs about 1,360 kg and is 1.22 m long. Stage four uses a liquid bi-propellant rocket propulsion system which provides velocity and attitude corrections for this phase of the Peacekeeper missile flight. Following the burnout and separation of stage three, the PBV manoeuvres into position for the release of the first RV. The PBV is then moved by its propulsion system to new positions where the remaining RVs are deployed in sequence. The propulsion system includes the liquid propellants and tanks, an axial engine and its thrust vector actuation system and an attitude control engine.

The missile Guidance and Control (G&C) system is contained in the post-boost vehicle. The G&C system includes the Inertial Measurement Unit (IMU), the missile electronics and computer assembly, ground and flight software, the in-flight cooling subsystem, airborne power supply and missile ordnance arm switch. The IMU contains an Advanced Inertial Reference System (AIRS) which has its own single reference platform for the guidance corrections, making it independent of component drift and resulting in improved accuracy. The G&C system also determines the correct release point for each of the RVs.

In addition to the three stages and PBV there is the nose-mounted MIRV system, which is 3.5 m long. It consists of the deployment module, the multiple RVs and a protective shroud (nosecone) to protect the RVs during ascent. It is believed that the PBV also carries a countermeasures suite. The shroud is topped with a nose cap made from a metal called Inconel, and contains a nose-mounted rocket motor to separate the nosecone from the MIRV system just before the final positioning manoeuvres of the PBV.

The deployment module provides the structural support for the RVs and carries the electronics to activate and deploy them. The RVs are mechanically attached to the deployment module, and once in the required position this attachment is broken by an explosive bolt, allowing the RV to separate with minimum disturbance.

The RVs, which contain the nuclear warheads, are conically shaped and covered with a material to protect the warhead during the flight down through the atmosphere to the target. Apart from the warhead and related components the RV contains the following subsystems: nose tip; impact fuze; Arming and Fuzing (A&F) system; antenna; and spin stabilisation. Before the missile's launch, while the weapon system is on alert, targeting, arming and fuzing functions are provided to each RV through the re-entry system electronics. After missile launch and during powered flight, additional functional signals are communicated to the RVs in preparation for deployment. After deployment the RV spin system is initiated to stabilise the released vehicle in its proper attitude throughout ballistic flight, in preparation for re-entry. Detonation of the nuclear warhead then occurs at a predetermined altitude above the target.

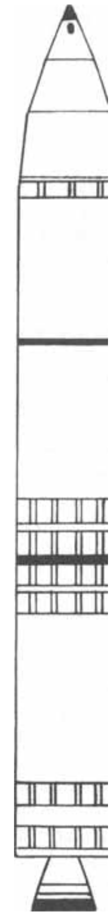
The Peacekeeper's MIRV system is capable of carrying 12 Mk 12A RVs or 11 advanced ballistic re-entry vehicles; but it carries only the 10 Mk 21 RVs permitted under START 1. Some missiles may carry less than 10 RV, but the START counting rules determine that each missile is regarded as having 10 RV and warheads fitted. Each RV contains a W87 nuclear warhead, with a yield of 300 to 475 kT, and has a reported accuracy of 90 m CEP.

Operational status

Planned production was originally to have been 21 per year over the period 1985 to 1989, but this was delayed and the total reduced; deployment began in August 1986 in modified Minuteman silos at F E Warren AFB in Wyoming. The total deployment of the 50 approved silo-based missiles was completed by the end of 1988, and a total of 114 missiles were built. The planned annual flight testing of Peacekeeper missiles has been reduced from seven to three. The first airborne controlled launch of a Peacekeeper missile was carried out in March 1989, the 18th test flight for this missile. In December 1986, development of the rail garrison system was authorised and, in November 1989, the USAF announced the seven sites that had been nominated as the bases for this deployment. In April 1989, it was decided to continue with the rail garrison deployment, but using the 50 missiles already deployed in silos, and not an additional 50 missiles. The rail launch option was cancelled in 1991, and the 50 silo based missiles remain in service at F E Warren AFB. Some in-service missiles may be fitted with less than 10 RV, but the precise numbers are not known.

In 2002 it was confirmed that Peacekeeper missiles would be taken out of service, and this began in October 2002, with completion expected by December 2005. Two missiles were destroyed in January 2001. Around 200 Mk 21 re-entry vehicles with W87 nuclear warheads will be modified and transferred to upgraded single warhead Minuteman III missiles.

Plans were reported in 1995 to adapt some Peacekeeper missile propulsion stages for conversion to civil satellite launch vehicles, with two launchers, known as Eagle S-1 and Eagle S-2, but it is



A line diagram of the LGM-118 Peacekeeper missile

believed that these plans were cancelled in 1998. A first stage motor was tested in April 2000 by Thiokol after 14 years' storage, and indicated that the original 10-year design life could be extended, with a target of 20 to 25 years the requirement. It is expected that some of the motor assemblies from deactivated missiles will be used for launching satellites, research vehicles and targets for the ballistic missile defence system.

Specifications

Length: 21.8 m
Diameter: 2.34 m
Launch weight: 87,750 kg
Payload: 10 Mk 21 RVs on MIRV platform
Warheads: W87 nuclear, 300 to 475 kT each
Guidance: Inertial
Propulsion: 3-stage solid propellant
Range: 9,600 km
Accuracy: 90 m CEP

Contractors

It is not always the practice of the US Air Force to appoint a prime contractor for its weapon systems, the preference being to have major system and integration contractors, with the final responsibilities for the system being taken by the service itself. The primary co-ordinator for the Peacekeeper programme is Lockheed Martin, Denver, Colorado. and Boeing Space and Communications Group, Seal Beach, California is the primary base support co-ordinator.

UGM-96 Trident C-4

Type

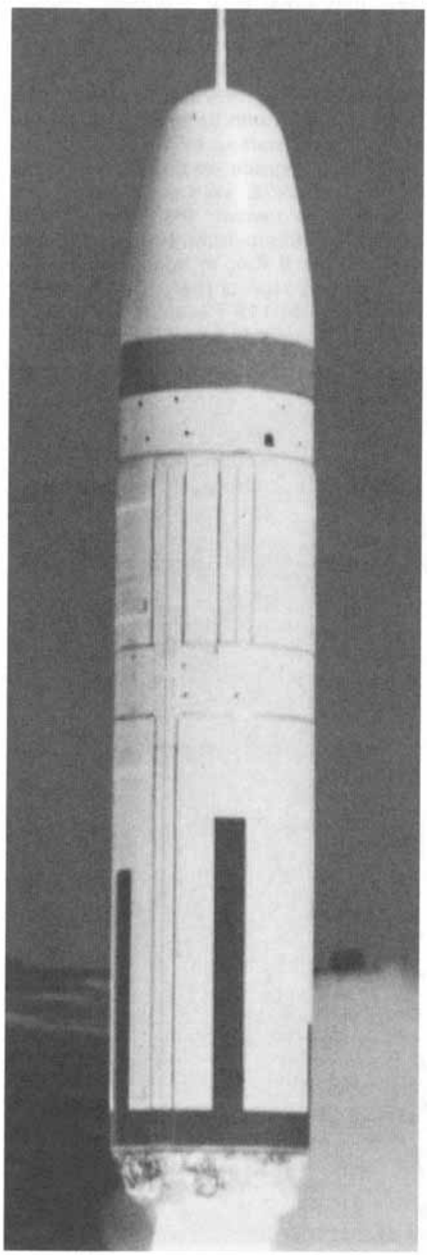
Inter-continental-range, submarine-launched, solid-propellant, MIRV-capable ballistic missile.

Development

The UGM-96 Trident C-4 missile was designed to improve on the range capability of the Poseidon missile, thus providing the fleet with more sea room and hence greater survivability. It was originally deployed in the 'Franklin' and 'Madison' class Poseidon submarines, and then in the 'Ohio' class. The 'Ohio' class is a much larger, 24-tube boat intended for the C-4 successor missile, the Trident D-5, but used for the C-4 until the D-5 missiles became available. C-4 missiles were fitted into the first eight 'Ohio' class boats. Apart from being smaller and lighter than the Poseidon, the guidance system for the Trident C-4 uses a stellar sensing unit to update the missile position and thus improve its accuracy. This enables the missile to maintain the Poseidon accuracy at the longer range.

There are two basic fire-control systems developed: the Mk 88 Mod 2 for retrofitting to the Poseidon boats; and the Mk 98 for the new 'Ohio' class boats. A new digital fire-control computer was also developed to handle the increased computational load in providing target settings on the larger boats. A new Mk 4 re-entry body was developed for the C-4 and a Mk 500 Evader, manoeuvre capable (MARV) system was put in development.

In 1997, the US Navy and US Army agreed to develop a hard target penetrator warhead for the MGM-140 ATACMS missile, using modified Mk 4 RVs taken from Trident C-4 missiles.



The first test launch of a Trident C-4 missile, at Cape Canaveral

Description

The Trident C-4 missile is a solid propellant, three-stage missile, 10.39 m long and 1.88 m in diameter. It has a launch weight of 32,850 kg and a maximum range of 7,400 km. The minimum range is around 2,000 km. The payload is MIRVed, with eight Mk 4 RVs with W76 nuclear warheads at 100 kT yield each, and a total throw weight of 1,500 kg. The missiles were downloaded from 8 RV to 6 RV in 2000/2001. It has an optional MARV package for ABM penetration, in keeping with its second strike retaliatory role. It is believed that all the missiles carry countermeasures, and that some missiles have less than eight warheads. A missile with a lighter payload could also have a greater range. An interesting innovation on the missile is the use of an 'aerospike', which is an extendable spike deployed from the missile nose after launch to reduce aerodynamic drag during the early phases of the missile's flight. Guidance is inertial, with stellar sensing updates, providing an accuracy of 450 m CEP at the maximum range.

The missile can be launched from the submarine when either on the surface or when submerged. The 'Ohio' class submarines have a Mk 98 fire control system for the C-4 missiles. The missile is ejected from the vertical launch tube using a gas generator (analogous to the cold launch technique of the Peacekeeper missile). The first stage ignites once the missile is clear of the surface.

Operational status

The UGM-96 Trident C-4 system entered service in 1979, following a development test series of 20 successful launches out of 23 attempts. There were eight 'Ohio' boats operational in 1987 each with 24 missile launch tubes, the C-4 missile was also carried on 12 of the former Poseidon boats, the 'Franklin' and 'Madison' classes; each with 16 missile launch tubes. It is estimated that approximately 385 Trident C-4 missiles were in operational service in 1991, although a total of 570 missiles were built between 1976 and 1986. By 1996, the only remaining Trident C-4 missiles were carried on eight 'Ohio' boats, with a total at 192 operational missiles. These boats are based at Bangor in Washington state, for the Pacific Fleet.

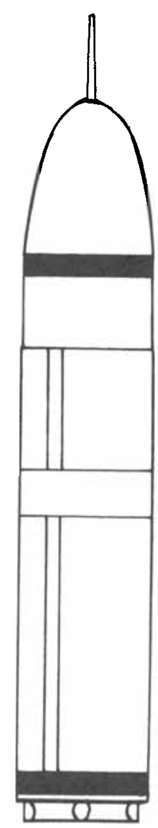
In 1998, it was announced that four 'Ohio' class boats would be modified to carry the larger Trident D-5 missiles, and in 2001 that the remaining four boats would be modified to carry up to 154 UGM-109 Tomahawk cruise missiles, 2 SEAL and 100 special operations personnel. It is expected that C-4 missiles will remain fitted to 'Ohio' class boats until around 2005. The missiles had an original life of 10 years, but this has been extended to 20 years. There had been 225 test launches of C-4 missiles up to December 2001, with five or six missiles fired each year and several missile fired in salvos of two, three or four.

Specifications

Length: 10.39 m
Body diameter: 1.88 m
Launch weight: 32,850 kg
Payload: 8 Mk 4 RVs in MIRV formation
Warheads: W76; 100 kT nuclear each
Guidance: Inertial with stellar reference update
Propulsion: 3-stage solid propellant
Range: 7,400 km
Accuracy: 450 m CEP

Contractor

Lockheed Martin Space Systems, Missile and Space Operations, Sunnyvale, California (prime contractor).



A line diagram of the UGM-96 Trident C 4 missile 0008579

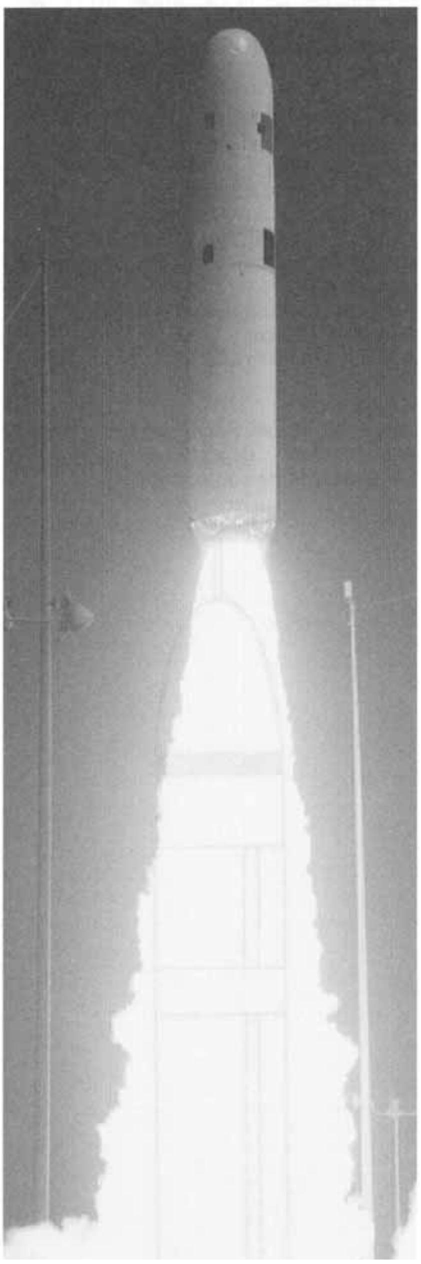
UGM-133 Trident D-5

Type

Inter-continental-range, submarine-launched, solid-propellant, MIRV-capable ballistic missile.

Development

The UGM-133A Trident D-5 missile, together with the 'Ohio' class boats, form the key component of the strategic nuclear deterrent capability for the US Navy. The D-5 not only extends the range, payload and inventory of the missile force, but it also introduces a hard target capability to the submarine-based missile. This accuracy has been achieved through improvements to the ship navigation system and to the missile.

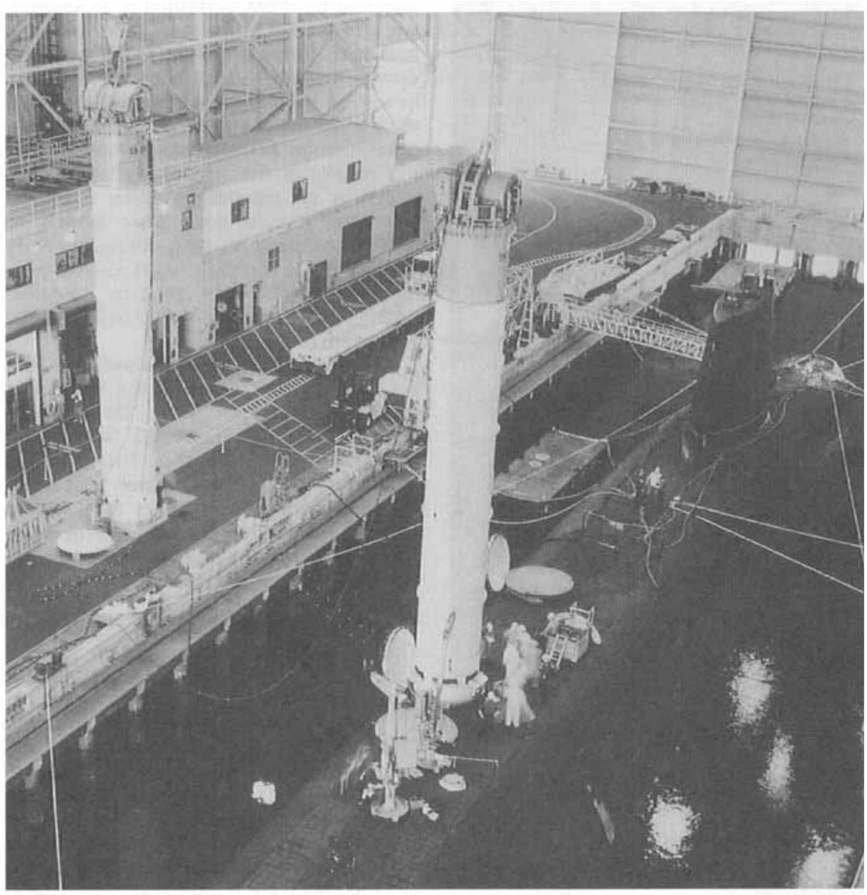


Launch of the second development test Trident D-5 missile from Cape Canaveral in March 1987

The first D-5 was launched from a land pad in January 1987, and the first sea launch, a failure, was in March 1989. The full test programme was completed with a total of 48 firings recorded by 1993. The original size of the 'Ohio' class was expected to be 24 boats which, with 24 tubes per boat, would have resulted in a total of 576 missiles of the D-5 type. From 1991, the total number of boats was reduced to 18 with the missiles reduced to 432, and a further rationalisation of boats and missiles has been made following the agreement to limit SLBM warhead numbers by the START 1 and 2 agreements.

Plans reported in 1995 suggested that the US Navy would be limited to 12 to 14 Trident D-5 'Ohio' class boats to 2001, and that four 'Ohio' class boats would remain with the C-4 missiles until 2000. A reduction to 14 boats for the Trident D-5 missiles was confirmed in 1998, and in 2001 there were 10 boats (pennant numbers 734 to 743) with D-5 missiles, and four boats with C-4 missiles. The four boats with C-4 missiles will be converted to D-5 standard by 2008, with redesigned weapon control systems using an open architecture software suite.

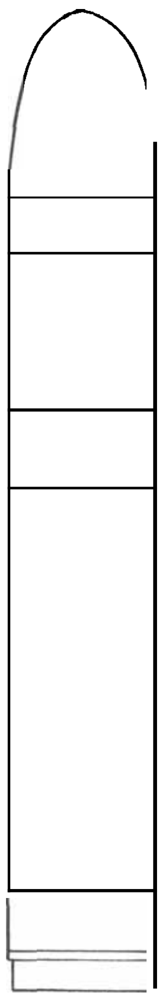
In 1999 the US Navy confirmed that the life of the 'Ohio' class boats would be extended to 42 years. It is expected that some of the D-5 missiles will be downloaded to carry 4 RVs, and reports indicate that single warhead and even conventional HE warhead versions are being considered for future development. The single warhead missiles would have a longer range. More accurate GPS-aided navigation systems have been tested in Trident missiles since 1993, to aid the delivery of conventional HE or penetrating warheads. An earth penetrator warhead was reported to be being considered for the Trident D-5 missile in 1994, to attack hardened underground facilities. A joint USN and US Army programme was announced in 1997 to develop a modified Mk 4 RV as a hard target penetrating warhead for the MGM-140 ATACMS missiles. In 1998, the US Navy stated that Mk 4 RVs were being examined to consider fitting an improved air burst fuze, for use with the existing W76 nuclear warheads. New third-stage solid propellant motors have been developed, and have been tested from 1999 to 2001. In 2001 it was reported that the USN were planning a major mid-life upgrade for the missiles, to a D-5A standard, with up to 300 missiles to be upgraded, starting between 2015 and 2020. This upgrade would include the Mk 4 RV and W76 warheads. There are proposals to re-open the production of W88 warhead pits from 2005, to be used with the Mk 5 RVs. In addition there are unconfirmed reports that W87 warheads from the LGM-118 Peacekeeper missiles may also be used in future D-5 missiles.



HMS Vanguard *loading with Trident D-5 missiles in 1994 before the first UK trials launch* (UK MoD)

Description

The Trident D-5 missile is a three-stage, solid propellant SLBM, it is 13.42 m long and has a body diameter of 2.1 1 m. It has a launch weight of 59,090 kg and a maximum range of 12,000 km. The minimum range is believed to be 2,500 km. The Mark 6 guidance system is inertial with a stellar sensor update, giving the missile a claimed accuracy of 90 m CEP. Like the C-4 missile, the D-5 carries an aerodynamic spike, which deploys from the nose early in flight to reduce the drag in the atmosphere. The missile is cold-launched from its launch canister by expanding gas from a gas generator, with the first stage motor igniting when the missile has broached the surface. The missile extends the use of weight-saving materials in US ballistic missiles, all stages having filament wound motor casings. The first stage length is 7.35 m with a diameter of 2.11 m and a launch weight of 39,241 kg. The propellant weight is 33,355 kg. The second stage is 3.12 m long, has a diameter of 2.1 I m and a weight of 11,866 kg. The propellant weight is 10,320 kg. The third stage is 3.27 m long, has a diameter of 0.86 m (motor casing) and a weight of 2,191 kg. The propellant weight is 1,970 kg. The first-, second- and third-stage motor assemblies, and the launch gas generator, are manufactured by Alliant Techsystems and Thiokol. The payload is from 8 to 12 MIRVs; these can be Mk 4 RV with W76 warheads at 100 kT each, or the Mk 5 RV with W88 warheads at 475 kT each. It is believed that the missiles have countermeasures fitted, and that some missiles may carry less than eight RVs, with numbers varying from one RV up to eight. A single warhead missile would probably have a range increased to 14,000 km. A throw weight of 2,800 kg was declared in 1991, together with a limit of 8 RVs under the START 1 counting rules. The 'Ohio' class submarines carry up to 24 missiles each, in vertical launch tubes, and these are controlled by a Mark 98 weapon control system.



A line diagram** of **the UGM-3 Trident D-5 missile

Operational status

The D-5 became operational with the US Navy in 1990, and by 1998 there were 240 missiles deployed in 10 boats. The boats are based at Kings Bay, Georgia, and operate with the Atlantic Fleet. The projected final force size was initially planned to be 24 boats, but this was reduced to 18, and from 1998 to 14 boats. Four boats are to be modified from carrying Trident C-4 missiles to carry the D-5. and no more new boats will be built. The plan is for 12 boats to be operational, with two boats in refit at any one time. The D-5 production programme has been slowed from 50 missiles to 12 missiles per year, with a planned number of 453 missiles to be built.

In June 2002 it was reported that 396 missiles had been built with 1,920 RVs and warheads, 1,536 Mk 4RV with W76 warheads, and 384 Mk 5 RV with W88 warheads. Production for the Mk 5 RVs ceased in 1989, and for the Mk 4 RVs ceased in 2000. There have been 116 D-5 missile flight tests up to July 2002, with a successful run of 95 tests without a failure from December 1989. A salvo of three missiles was made in June 2001. A further 135 flight tests are planned up to 2020, with 288 missiles on the operational boats. It is suggested that 300 missiles will be converted to the D-5A standard by 2020, with their lives extended to 2042.

Agreement was reached with the UK for the sale of Trident D-5 missiles in 1980 and the missiles use the US designed MIRV bus with US Mk 4 RVs, but with UK-built warheads believed to be similar to the US designed W76 warheads at 100 kT. It has been officially stated that the UK missiles will carry up to eight warheads each, but it is expected that there will be between one and four warheads fitted to most missiles. The UK plans to use some Trident D-5 missiles in a 'sub-strategic' role, with a single warhead set to produce a smaller yield, believed to be around 10 kT. The UK has built four 'Vanguard' class Trident carrying Ballistic Missile Nuclear-Powered Submarine (SSBN), and they each have 16 missile launch tubes. The boats are based at Faslane. Scotland. A statement in 1999 clarified the situation with regard to the maximum number of warheads to be carried by each boat, which will be limited to 48. This implies that 16 missiles will carry three warheads each, or that there will be a mixture of single warhead sub-strategic missiles and strategic missiles with three or four warheads each. Two missiles were launched in mid-1994, a third in July 1995, and a fourth in September 2000, during crew qualification trials. The UK Trident system entered service in 1994 and it is reported that the UK has ordered 58 missiles, making three boat loads with an additional 10 missiles for flight tests.

Specifications

Length: 13.42 m
Body diameter: 2.1 1 m
Launch weight: 59,090 kg
Payload: 8 Mk4 or Mk5 RVs in MIRV formation
Warheads: 8 W76 at 100 kT or 8 W88 at 475 kT
Guidance: Inertial with stellar reference update
Propulsion: 3-stage solid propellant
Range: 12,000 km
Accuracy: 90 m CEP

Contractor

Lockheed Martin Space Systems, Missile and Space Operations, Sunnyvale, California.

RGM/UGM-109 Tomahawk

Type

Intermediate-range, ship- and submarine-launched, turbofan-powered, single-warhead cruise missiles.

Development

The development of surface-launched cruise missiles started, together with work on air-launched cruise missiles, in the USA in 1972. The US Navy programme aimed to provide a ship- and submarine-launch capability for attacking ships and land targets; primarily in the early days with nuclear warheads, to provide an additional survivable nuclear force. The first underwater launch test took place in 1976, and General Dynamics (Hughes Missile Systems and now Raytheon Missile Systems) won the development contract against a BGM-110 designed by LTV (now Lockheed Martin). The first vertical launch was made in 1979 and the first ship launch in 1980. Both US Navy and USAF cruise missile programmes competed, but the US Navy stayed with the BGM-109 Tomahawk programme and it entered service in 1983. However, the missiles were re-designated in 1986 as the RGM-109 (ship-launched) and UGM-109 (submarine-launched) Tomahawk.

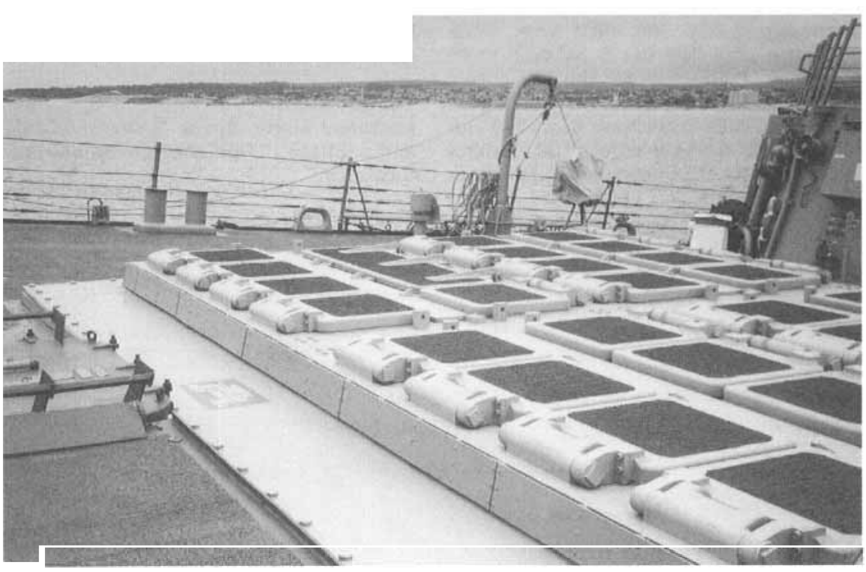
Originally there were three versions of ship- and submarine-launched cruise missiles: RGM/UGM-109A, a nuclear warhead missile called TLAM-N (Tomahawk Land Attack Missile-Nuclear); RGM/UGM-109B, a conventional HE warhead anti-ship missile called TASM (Tomahawk Anti-Ship Missile); and RGM/UGM-109C, conventional HE warhead land attack missile TLAM-C (Tomahawk Land Attack Missile-Conventional). A fourth version, RGM/UGM-109D, a conventional submunition warhead land attack missile TLAM-D entered service in 1989. The air-launched variants, AGM-109H and AGM-109L, were cancelled in development and the seventh version, BGM-109G Griffin, became the ground-launched cruise missile. The BGM-109G missiles entered service in Europe, operated by the USAF, in 1984, but following the 1987 INF Treaty they were all removed from service by 1991. Plans for RGM/UGM-109E and -109F versions were terminated in the mid-1980s.

The initial build of Tomahawk missiles was to a Block 1 standard, including TLAM-N and TASM versions. The Block 2 standard introduced the Digital Scene Matching Area Correlation (DSMAC) navigation system, specifically for the TLAM-C and TLAM-D versions. The Tomahawk Block 3 upgrade programme includes a GPS receiver, time of arrival control, improved guidance computer, warhead and propulsion systems. The first test flight was completed in February 1991. The Block 3 upgrade programme has only been applied to the land attack versions, TLAM-C/-D, and has been retrospectively embodied on some earlier Block 2 missiles. The Block 3 warhead for TLAM-C is reduced in weight to 318 kg, allowing for more fuel and additional range. A Tomahawk Block 4 upgrade programme began in 1994, when it was known as the Tomahawk Baseline Improvement Programme (TBIP). This was aimed at improving the capability of anti-ship (TASM) and earlier Block 2 TLAM-C missiles, including a two-way satellite UHF communications link for in-flight target changes and improved anti-jamming protection to the GPS receiver. The original Block 4 upgrade programme was terminated in June 1998, with the funding of the Tactical Tomahawk development programme, which is now known as the Block 4 programme.

A Block 5 upgrade programme was proposed in 1997, to include a 2-hour loiter capability and rapid re-targeting by forward air controllers. This became part of the Tactical Tomahawk Block 4 proposal, which started engineering and manufacturing development in 1998. Tactical Tomahawk is a completely redesigned missile, increasing the range and halving the production cost, for use from ships and submarines. Tactical Tomahawk will be designed with a unitary HE warhead, but submunition, penetrator and anti-radar warhead options are being considered. An upgraded Tercom navigation system, known as Precision Terrain Aided Navigation (PTAN), is being developed using a worldwide digital database with stored synthetic aperture radar maps, to augment -the present navigation aids. The UK has examined the possibility of launching Tactical Tomahawk missiles from submarine torpedo tubes, as the US Navy did not fund this option, and a joint US/UK development programme has been agreed. In 1998, the US Navy initiated a study to reconsider upgrading some TLAM-C Block 2 missiles to the improved Block 3 standard, particularly to fit GPS to the Block 2 missiles to reduce the time required for mission planning. In 1999 the US Navy studied a proposal to modify some of the remaining RGM/UGM-109A TLAM-N and -109B TASM anti-ship missiles to convert these to TLAM-C Block 3 standard.

In 1992, a modified Tomahawk variant was proposed to the UK for air-launch, known as Airhawk, with a range of 250 km. This proposal was modified in 1995, and resubmitted to the UK as well as to the US Joint Air-to-Surface Standoff Missile (JASSM) programme with a range increased to 600 km. This proposal was not continued.

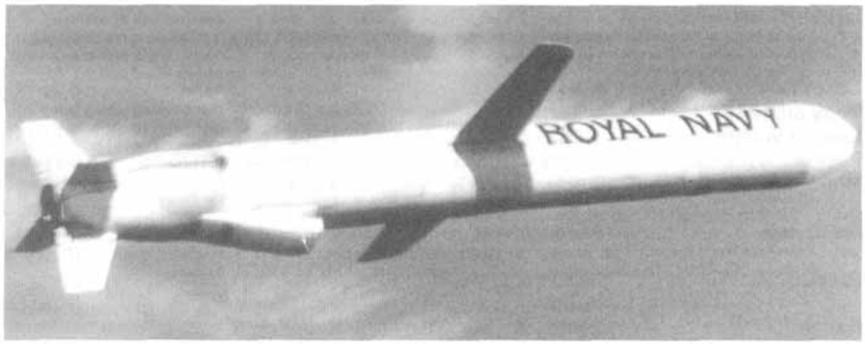
Existing RGM/UGM-109A, B, C and D versions can be carried in eight US ship and



The forward 29 cell Mk 41 VLS hatches on an 'Arleigh Burke' class destroyer (Barbara Parker) 0038272

A submarine-launched UGM-109C Tomahawk missile leaving the water during a trials launch (US Navy) 0062321

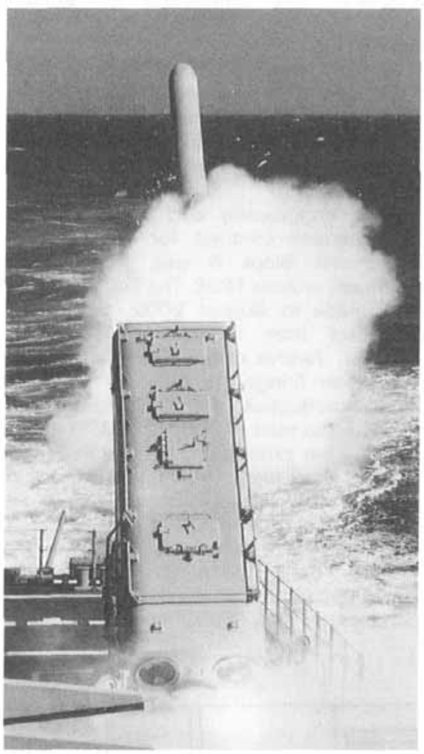
submarine types, and launched from Armoured Box Launchers (ABL), Vertical Launch System (VLS), Capsule Launch System (CLS), which is a vertical launch system in submarines, and from conventional Torpedo Tubes (TT). Most ships and submarines carry reloads, with the planned load of SLCM per ship varying from eight for a 'Narwhal' class submarine to 56 on an 'Arleigh Burke' class destroyer. Tomahawk cruise missiles have been carried on 'Seawolf' (45). 'Sturgeon' (23). 'Los Angeles' (26 in tubes or 12 CLS), and 'Narwhal' (8) class SSNs; on 'Virginia' class cruisers (8); on 'Ticonderoga' class cruisers (32); and 'Arleigh Burke' (56) and 'Spruance' (45) class destroyers with the US Navy. Tactical Tomahawk missiles are planned for the converted 'Ohio' class SSGN (up to 154). and on 'Virginia' class SSN.



A UGM-109 Tomahawk TLAM-C(UK) missile in flight in November 1998 (US Navy)
0062322

Description

RGM/UGM-109 Tomahawk missiles are 6.25 m long, including a solid-propellant booster motor mounted at the rear of the missile, have a body diameter of 0.52 m and an unfolded wing span of 2.6 1 m. The boost motor assembly has a length of 0.66 m, a diameter of 0.483 m, and a weight of 252 kg. The missiles have four clipped-tip delta control fins at the rear and an underbody engine air inlet that is lowered after launch. The launch weight, including the boost motor assembly, is 1,452 kg. The missiles have a Williams International F107-WR-400 turbofan engine, weighing 65 kg and producing around 272 kg of thrust. The solid-propellant, thrust-vectored boost motor is used to accelerate the missile from its launcher container, and is jettisoned after burnout. Ship-launched RGM-109 missiles use the Mk 106 boost motor assembly and submarine-launched UGM-109 missiles use the Mk 111. Both boost motors burn for around 12 seconds. Submarine-launched missiles are ejected vertically from the Capsule Launch System or horizontally from 533 mm torpedo tubes, with the steel or composite launch canisters remaining in the submarine. The Mk 111 boost motor is ignited after the missile leaves the submarine, and powers the missile through the water and into the air. The missile then rolls to its flight position, the wings flip-out, the turbofan motor air-inlet drops down, and the motor is started. The boost motor is then jettisoned.



RGM-109 Tomahawk missile being launched from a Mk 44 armoured box launcherassembly, from **USS** Mississippi *in January 7991* (US Navy)

Guidance varies between the different versions; for the RGM/UGM-109A (TLAM-N) there is inertial navigation with terrain-contour matching (TERCOM). RGM/UGM-109B (TASM) has inertial plus active radar terminal guidance. The RGM/UGM-109C and RGM/UGM-109D (TLAM-C and TLAM-D) have inertial and TERCOM mid-course guidance with Digital Scene Matching Area Correlation (DSMAC) for terminal guidance. The active radar seeker used by the TASM version is a Texas Instruments (now Raytheon) AN/ DSQ-28 and this is supported with a passive radar receiver system. Terrain-contour matching is achieved by storing digital terrain profile map information in the missile before launch, and comparing this with radar altimeter measurements of ground elevations below the missile, during a set number of sections on the route to the target. It is reported that this system has an accuracy of between 30 and 185 m.

The Block 3 upgrade programme includes a GPS receiver to supplement the TERCOM system, but it is believed that this upgrade was only applied to the TLAM-C version. The terminal phase digital scene matching area correlation system uses a stored digital representation of the target area and compares this with the scene viewed below the missile by a TV camera. The CCD camera has an image intensifier for bad weather or night operations and a Xenon flash illuminator. This latter system is claimed to be extremely accurate for attacking land targets and a Circular Error of Probability (CEP) of 10 m has been reported.

The RGM/UGM-109A (TLAM-N) has a W80 nuclear warhead weighing 135 kg and a reported yield of 200 kT. RGM/UGM-109B and RGM/UGM-109C both use old AGM-1'2 Bullpup B 454 kg unitary HE warheads, while the RGM/UGM-109D (TLAM-D) has 166 combined effects bomblets BLU-97B each weighing 1.5 kg and with shaped charge, fragmentation and incendiary capabilities. The RGM/UGM-109D submunitions can be dispensed in groups against up to four separate targets. The Tomahawk TLAM-C Block 3 build standard missiles have a smaller WDU-36B 315 kg warhead, carrying a unitary HE charge with a selectable fuze delay to increase warhead penetration before detonation. The warhead bay has a length of 1.26 m, a diameter of 0.38 m, and contains 123 kg of PBXN explosive. Both the RGM/UGM-109C and RGM/UGM-109D (TLAM-C and TLAM-D) versions have a programmable terminal-dive attack mode option.

Ships carry the AN/SWG-3 Tomahawk Weapon Control System (TWS) or the Advanced TWS. Tomahawk cruise missiles can be launched from standard 533 mm torpedo tubes from submarines, with the missiles in stainless steel Teflon-coated Mk 45 capsules each weighing 1,900 kg when loaded. Later 'Los Angeles' class submarines have 12 vertical launch tubes, known as the Capsule Launch System (CLS), the Mk 36 VLS, with lighter composite missile capsules. The earlier 'Virginia' and 'Ticonderoga' class cruisers launched Tomahawk using the Mk 44 Armoured Box Launcher (ABL), carrying four missiles that are raised to 35" for firing. The Mk 44 ABL weighs around 26,000 kg. Later 'Ticonderoga' cruisers and 'Arleigh Burke' and 'Spruance' destroyers use Mk 41 Vertical Launch Systems, with the missiles inside Mk 14 canisters. A typical Mk 41 module can carry Tomahawk, RIM-66/-67 Standard, RUM-I39 VL-ASROC, and RIM-7 Sea Sparrow missiles, with a fully loaded weight exceeding 75,000 kg. Unconfirmed reports suggest that some Tomahawk missiles used in the 1990-91 Gulf War were fitted with high-power microwave (EMP) generators in place of warheads, to disrupt electronic circuits. Some other missiles are reported to have unrolled spools of carbon fibre, to cause shorting between electrical power supply cables. The missiles are programmed to fly at low altitude, varying from 100 m for longer-range missions to 15 m for shorter range. Overland the TERCOM system generally operates at 30 m altitude. The TASM version is believed to be able to make a 'pop-up' manoeuvre and dive on to the target ship.

Specifications

	RGM/UGM-109A (TLAM-N)	RGM/UGM-109B (TASM)	RGM/UGM-109C (TLAM-C)	RGM/UGM-109D (TLAM-D)
Length	6.25 m	6.25 m	6.25 m	6.25 m
Body diameter	0.52 m	0.52 m	0.52 m	0.52 m
Launch weight	1,452 kg	1,452 kg	1,452 kg	1,452 kg
Payload	Single warhead	Single warhead	Single warhead	Single warhead
Warhead	Nuclear 200 kT	454 kg HE	454 kg (Block 2), 315 kg (Block 3)	Submunitions
Guidance	Inertial and tercom	Inertial and active radar	Inertial, tercom, GPS (Block 3) and DSMAC	Inertial, tercom, GPS (Block 3) and DSMAC
Propulsion	Solid booster and turbofan	Solid booster and turbofan	Solid booster and turbofan	Solid booster and turbofan
Range	2,500 km	450 km	900 km (submarine) 1,300 km (ship) (Block 2) 1,150 km (submarine), 1,700 km (ship) (Block 3)	900 km (submarine) 1,300 km (ship)
Accuracy	80 m CEP	30 to 185 m CEP	10 m CEP	10 m CEP

The Tomahawk family of missiles has varying range capabilities, largely affected by the weight of the guidance systems and warheads used. RGM/UGM-109A (TLAM-N) has a range of 2,500 km, RGM/UGM-109B (TASM) has a range of 450 km, and RGM/UGM-109C and D (TLAM-C and D) have ranges of 900 km when launched from submarines or 1,300 km when launched from surface ships. The range of the Block 3 TLAM-C missile, has been increased to 1,150 km when launched by submarines, and to 1,700 km when launched by surface ships due to increased fuel capacity and more efficient turbofan engines.

The Tactical Tomahawk Block 4 version has been totally redesigned with fewer components and assemblies. This version has forward swept thin rectangular wings, a new lower-cost turbojet engine, and a new boost motor with only three control fins. The missile can be pre-programmed with several targets before launch, and will be able to loiter for 2 hours at a range of 450 km. It will be capable of being updated with new targets during flight, and will carry a TV camera in the nose to take target battle damage pictures. The target updating and TV pictures will have a UHF satellite datalink to receive the updates and relay target battle damage pictures back to the launch platform. Tactical Tomahawk will have a GPS receiver and may also be fitted with the DSMAC terminal guidance system. Initially the missile will be fitted with a WDU-36/B 315 kg unitary HE warhead, but there are proposals for submunitions (such as 16 BAT or 166 BLU-97/B) for a Tactical Tomahawk Dispenser (TTD), or a hard target penetration warhead using a 483 kg version of the AUP-3M warhead for a Tactical Tomahawk Penetrator Variant (TTPV). It is expected that the missile will have a maintenance interval of 15 years, greatly reducing the in-service cost when compared with the present Tomahawk missiles. Tactical Tomahawk will weigh about the same as existing versions, 1,452 kg, but will carry more fuel and will have a maximum range of 2,800 km when ship-launched. For submarine launch the range is expected to be less, and only the Mk 36 Capsule Launch System will be used, as the missiles will not have the structural capability to cope with launching from torpedo tubes. A joint US/UK development programme will provide a capsule for the missile, so that it can be launched through standard 533 mm torpedo tubes. Tactical Tomahawk was to have had an upgraded version of the Teledyne J 402 turbojet but, in December 1999, this was changed to a Williams International version of the F 122 turbofan developed for the MAW Taurus KEPD 350 missile. Raytheon is developing a precision terrain-aided navigation system for the Tactical Tomahawk, using a radar altimeter and new precision maps from radar satellite data, providing a resolution of 30 m. This new navigation system may be fitted into later missiles as an upgrade. Tactical Tomahawk will be launched vertically using a newly designed Multiple All-up round Canister (MAC) in the 'Ohio' class submarines, with 7 missiles in place of one SLBM in 22 of the 24 SLBM launch tubes.

Operational status

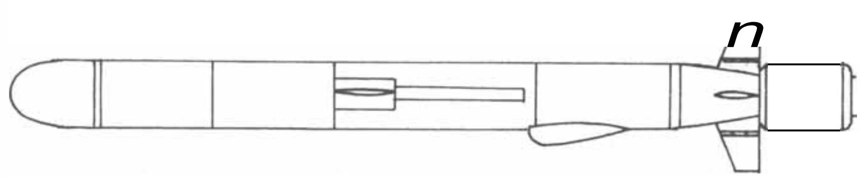
The RGM/UGM-109 Tomahawk entered service with the US Navy in 1983, and a total of nearly 4,000 missiles was originally scheduled for production. The RGM/UGM-109A (TLAM-N) 637, RGM/UGM-109B (TASM) 593, RGM/UGM-109C (TLAM-C) 1,486, and RGM/UGM-109D (TLAM-D) 1.157 production totals were scheduled to be reached by 1998, but this original programme has been modified. TASM entered service in 1983, TLAM-N in 1984, TLAM-C in 1986 and TLAM-D in 1988. The first vertical launch systems became operational on ships in 1987. Block 3 programme missiles started flight tests in 1991, and entered service in 1993. In July 2001 it was estimated that the US had around 320 TLAM-N (nuclear), 320 TASM (anti-ship), and 2,900 TLAM-C and TLAM-D missiles in stock. The TLAM-N missiles are believed to be held in storage at Kings Bay. It is believed that the TLAM-C/-D missiles are divided into 800 Block 2 and 2,100 Block 3 missiles. Block 3 production was completed in January 1999, and the US Navy upgraded 624 TASM and Block 2 TLAM-C/-D to Block 3C standard, with a further 476 missiles ordered for upgrading in March 2002.

In 2001 the USN announced that four Ohio class Trident C-4 boats would be converted to SSGN attack submarines, carrying up to 154 Tomahawk cruise missiles, using the C-4 missile vertical launch tubes with multiple all-round canisters holding seven Tomahawk missiles in each tube.

A second source contract was placed with McDonnell Douglas (now Boeing) in 1982, and they competed with General Dynamics (Hughes Missile Systems and now Raytheon Missile Systems) on production orders from FY85 with Teledyne CAE competing for engine production with Williams International from FY89.

In 1994, Hughes Missile Systems (now Raytheon) was awarded a single-source contract for future Tomahawk production and development, eliminating McDonnell Douglas (now Boeing) as prime contractors.

An engineering and manufacturing development contract for the Tactical Tomahawk Block 4 was placed with Raytheon in June 1998. The first flight test was made in August 2002, with DT-0 launched from a ground-based VLS canister. Twelve development and initial evaluation firings are planned. Low-rate initial production for 45 missiles is expected to start in 2002/2003. The first missiles are expected in service in 2004. The US Navy plans to buy 1,343 Block 4 missiles with a production rate of around 500 missiles per year, and it is expected that this figure will include 225 TTPV missiles with penetrating warheads. Lockheed Martin was awarded an EMD contract in May 1999 for the Tactical



RGM/UGM-109 Tomahawk

Tomahawk Control System. A demonstrator has been funded with four Block 4 missiles to be modified with US Navy China Lake-designed AUP-3M penetration warheads fitted, for tests to be made in 2002 against hardened targets.

The US withdrew all nuclear armed weapons from ships and SLCM from submarines in 1993, and this included 100 RGM/UGM-109A (TLAM-N) Tomahawk missiles. Tomahawk cruise missiles were fired during the 1990-91 Gulf War, a total of 264 TLAM-C and 27 TLAM-D, with about 15 of these missiles launched from two submarines. A mission success rate exceeding 85 per cent has been reported for the 291 missiles launched. A further 45 missiles were fired at industrial targets in Iraq in January 1993 and 23 in July 1993. In September 1995, attacks in Bosnia used 13 Tomahawk missiles, all ship-launched, and it is believed that these were the first Block 3 missiles to be used operationally. A further 31 missiles were fired at targets in Iraq in 1996.

In August 1998, 79 missiles, all believed to be Block 3 standard with 13 TLAM-C and 66 TLAM-D, were fired from US ships and submarines against a factory target in Khartoum, Sudan and at terrorist camps in Afghanistan. In December 1998 around 325 TLAM-C/-D missiles were fired at targets in Iraq and, in 1999, a total of 238 TLAM-C/-D was fired at targets in Serbia and Kosovo, 218 launched by the USA and 20 from UK submarines.

In October 2001 some 50 to 70 missiles were launched against Afghanistan. A total of 368 test flights for all marks of Tomahawk missiles had been made by February 1999, and the US Navy continues with around 10 training and test launches per year. There have been around eight to ten reported incidents concerning unexploded missiles landing in enemy or neutral territory from 1991 to 2001, and it is believed that these missiles have been used to re-engineer components and assemblies for use in other missile programmes around the world.

In October 1995, the first export order for Tomahawk missiles was announced, with the UK ordering 65 missiles, Advanced Tomahawk Weapon Control Systems for seven boats, and a shore-based mission planning system. These are to be fitted to seven 'Trafalgar', two 'Swiftsure' and three 'Astute' class submarines, and the missiles are UGM-109C TLAM-C versions to the Block 3C build standard, to be launched from standard torpedo tubes. Two unguided test rounds and one guided flight were made from a 'Swiftsure' class boat in 1998, and a fourth test was made in August 2001. The UK fired 20 missiles against targets in Serbia in early 1999, and ordered 20 replacement missiles in May 1999. The replacement missiles will probably be US Navy Block 2 missiles upgraded to the Block 3C standard. A further 22 missiles were ordered in March 2002. It is expected that the UK will order a total of 200 missiles.

Tactical Tomahawk missiles have been requested for export by Australia, Canada and the UK, and it is believed that the UK order could be for 300 missiles.

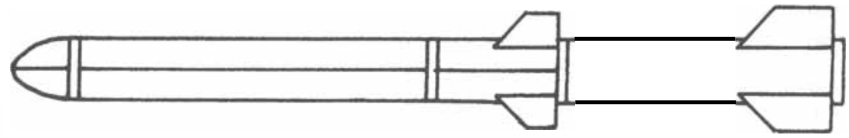
Contractor

Raytheon Missile Systems, Tucson, Arizona (prime contractor).

RUR-5 ASROC

Type

Short-range, ship-launched, solid-propellant, single-warhead, anti-submarine rocket.



RUR-5 ASROC rocket

Development

The US Navy's need for a short-range quick-reaction ASW system led to the development of ASROC (Anti-Submarine Rocket), which began in 1956. The original design has been updated at intervals since the 1960s, with five major versions, the RUR-5A, -5B, -5C, -5D and -5E. The original ASROC carried a Mk 44 torpedo, but these have been replaced with the present Mk 46 torpedo in US Navy service, although some Mk 44 torpedo versions remain in service with other navies. Plans to develop the ASROC system to use a Vertical Launch System (VLS) for surface ships and attack submarines, were at first suspended on grounds of cost and a need to merge the project with the ASW-SOW standoff weapon programme.

However, changes in the USN's overall ASW policy led to a reversal of that decision in 1982 and development of RUM-139 Vertical Launched ASROC (VLA) by Loral Systems Group (now Lockheed Martin) started in 1984. This will replace the original RUR-5 ASROC deployed on surface ships. ASROC was fitted to guided missile cruisers of the 'Virginia', 'California', 'Bainbridge', and early 'Ticonderoga' classes with up to 20 missiles carried per ship. Guided missile destroyers of the 'Kidd' class carried up to 16 missiles each and the 'Spruance' class destroyers carried 24.

Description

The RUR-5 ASROC is basically an unguided rocket with either a depth charge (which can be nuclear) or a Mk 44 or Mk 46 acoustic torpedo enclosed in a split shell flared into the front end of the rocket. The jettisonable rocket motor and the front end shell each have four stabilising fins at the rear. The overall weapon is 4.57 m long, has a body diameter of 0.33 m and weighs 435 kg at launch. The payload for USN use was normally a 1 kT W44 nuclear warhead in a Mk 17 nuclear depth charge, whereas with other users it would be a conventional HE depth charge or a Mk 44 or Mk 46 torpedo. The Mk 44 torpedo has a weight of 233 kg and a 34 kg HE warhead, using active sonar homing with a range of 5 km. The Mk 46 torpedo has a weight of 230 kg and a 44 kg HE warhead, using an active/passive sonar seeker and with a range of up to 11 km.

ASROC is fired from an eight-cell launcher Mk 16 or Mk 112 (which is also used for Harpoon), the Mk 26 launching system, or from the Mk 10 Terrier (SAM) missile launcher system. At a predetermined point the rocket motor is jettisoned, and the steel band that holds the front shells together is broken by an explosive charge and the payload continues towards the target. If the payload is a torpedo, it is slowed into the water by a parachute, where its homing mechanism is activated upon submersion. Depth charge payloads sink to a predetermined level before detonating.

Operational status

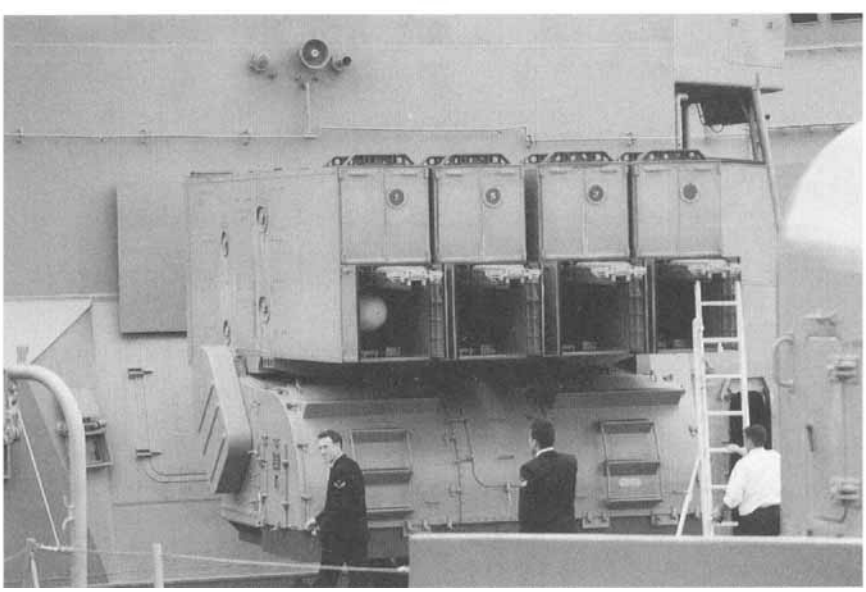
The RUR-5 ASROC entered service in 1961, and limited spares production is believed to be still in progress. In 1989, some 500 nuclear warheads with 912 launchers remained in service installed in about 135 US Navy surface vessels, but in 1991, the US government announced the withdrawal of nuclear warheads for ASROC from all ships. RUR-5 is still in service with the US Navy, being carried by early 'Ticonderoga' class cruisers and in some 'Spruance' class destroyers. A total of around 12,000 missiles were built. The conventional HE ASROC system remains in operational service with several other countries including Brazil, Canada, Egypt, Germany, Greece, Japan, South Korea, Mexico, Pakistan, Spain, Taiwan, Thailand and Turkey.

Specifications

Length: 4.57 m
Body diameter: 0.33 m
Launch weight: 435 kg
Payload: 235 kg Mk 44 or Mk 46 torpedo or nuclear depth charge
Warhead: 34 kg or 44 kg HE or 1 kT nuclear (W44)
Guidance: Non-guided
Propulsion: Solid propellant
Range: 10 km
Accuracy: n/k

Contractor

Honeywell Training and Control Systems. West Covina, California.



An RUR-5 ASROC Mk 16 eight-cell launcher on a 'Tepe' class frigate of the Turkish Navy (van Ginderen Collection) 0038273

An evaluation trials RUR-5A ASROC rocket being loaded into its launcher (US Navy)

RUM-I 39 VL-ASROC

Type

Short-range, ship-launched, solid. propellant, single-warhead, anti-submarine missile system.

Development

Development of the RUM-I39 VL-ASROC (Vertical Launch Anti-Submarine Rocket) started in 1984 and was planned as a replacement for the RUR-5 ASROC that entered service in 1961. The programme was delayed in 1988 as the USN considered procurement of UUM-125 Sea Lance, but Sea Lance was cancelled in 1990 and, in 1991, the USN restarted VL-ASROC. Some 30 trial launches were made, starting in 1992, and the missiles started operational evaluation in 1993. The missile can carry Mk 46, Mk 50 or Mk 54 torpedoes. Proposals have also been made to carry a MU 90 Impact or a Stingray torpedo. In June 2001 Lockheed Martin proposed that the missile was adapted to also carry submunitions, in a new version known as the Vertical Launch Autonomous Attack System (VLAAS). The VLAAS would carry four or six P-LOCAAS submunitions, to attack ships, land targets or small craft. The P-LOCAAS submunition has a small turbojet engine, and can fly 185 km. Each submunition weighs 39 kg, and has a 7.7 kg HE warhead. Guidance is provided by INS/GPS for mid-course, followed by a ladar terminal seeker.

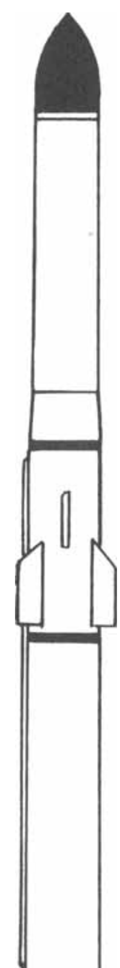
In 2002 research into a supercavitating torpedo, similar to the Russian Shkval VA-111, indicated that a future modification to RUM-I39 might introduce a 200 kt capability. VL-ASROC is fitted to ships equipped with the Mk 41 vertical launch system and the Mk 116 Mods 6/7/8 anti-submarine warfare combat system. RUM-I39 is fitted to 'Ticonderoga' (Aegis) class cruisers, 'Arleigh Burke' and 'Spruance' class destroyers.

Description

VL-ASROC has a length of 4.89 m, a body diameter of 0.36 m and weighs 634 kg at launch. The carrier missile has a Mk 210 inertial guidance unit, with a solid propellant boost motor fitted with thrust vector control that separates from the carrier missile after burnout. A Mk 114 solid propellant sustainer motor in the carrier missile gives the system a maximum range of 17 km, and a minimum range of 1.6 km. The torpedo payload separates before the missile impacts with the water, and a parachute is deployed to slow the payload torpedo assembly before it enters the water and begins to search for the submarine target. The payload will be the Mk 46 torpedo, a training torpedo, the Mk 50 advanced lightweight torpedo (Barracuda) or the Mk 54 torpedo. The Mk 46 torpedo is 2.9 m long and has a launch weight of 230 kg with a 44 kg HE warhead. This torpedo has a range of up to 11 km using an active/passive sonar seeker. The Mk 50 Barracuda is 2.9 m long and has a launch weight of 363 kg with a 45 kg HE warhead. This torpedo has a range of up to 20 km using an active/passive sonar seeker. The Mk 54 torpedo is 2.72 m long, and has a launch weight of 276 kg with a 45 kg HE warhead. The range is 20 km and the Mk 54 uses the same active/passive sonar sensor as the Mk 50 but with improved processors.

A Mk 6 training/evaluation torpedo can be carried instead of the operational torpedoes. The VL-ASROC missiles, in sealed Mk 15 canisters, can be launched from both the tactical and strike Mk 41 vertical launch systems, which can carry RIM-7 Sea Sparrow, RIM-66/-67 Standard and RGM-109 Tomahawk missiles as well. In addition, the missiles can be launched from above-deck box launchers. The Mk 15 canisters are 5.84 m long, have a diameter of 0.64m, and a weight of 1,440 kg.

A RUM- 739 VL-ASROC leaves the Mk 47 vertical launcher during a test firing



RUM- 139 VL-ASROC ***missile***

Operational status

RUM-I39 started development in 1984, production started in 1993 and the first missiles entered service in 1995. Lockheed Martin (formerly Loral Systems) was under contract to build 354 missiles, but it is reported that the USN finally ordered 443 missiles. USN production ceased in 1999. An export order was placed by Japan, for around 400 missiles for fitting to Murasarne and Kongou class destroyers. Each ship carries 16 missiles with 13 reloads.

Specifications

Length: 4.89 m
Body diameter: 0.36 m
Launch weight: 634 kg
Payload: 230 kg Mk 46 torpedo, 363 kg Mk 50 torpedo, or 276 kg Mk 54 torpedo
Warhead: HE 44 kg (Mk 46), or HE 45 kg (Mk 50 and 54)
Guidance: Inertial
Propulsion: Solid propellant
Range: 17 km
Accuracy: n/k

Contractor

Lockheed Martin Naval Electronics and Surveillance Systems, Akron, Ohio.

AGM/RGM/UGM-84 Harpoon/SLAM/SLAM-ER

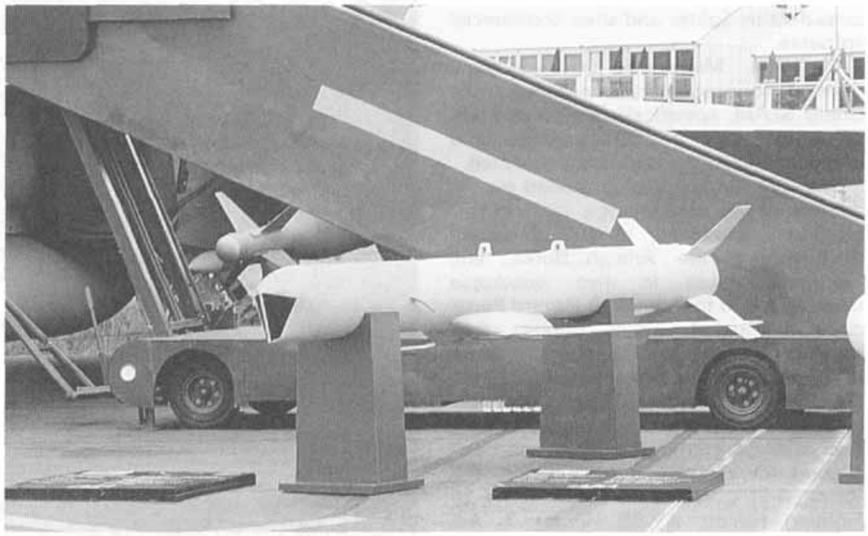
Type

Short-range, ship-, submarine-, air- and ground-launched, turbofan-propelled, single-warhead, air-to-surface and surface-to-surface missiles.

Development

The US Navy began studies for an anti-ship missile system in 1965, at the same time that McDonnell Douglas (now Boeing) was conducting similar private studies. In July 1971, McDonnell Douglas won the development contract and, in May 1973, the US Navy selected the Harpoon as its prime Anti-Surface Vessel (ASV) missile for aircraft (AGM-84A), submarines (UGM-84A) and surface ships (RGM-84A). All three systems entered service in 1977 and since then there have been A, B, C, D, E, F, G, H, J, K and L versions in service with several different build standards. A nuclear version was studied in 1979 but not funded into development.

Over the years there have been several improvement programmes, the Block 1B, 1C, 1D, 1E (SLAM), 1G, SLAM-ER, 1J and Block 2. The Block 1 initial build standard missiles were designated AGM/RGM/UGM-84A in US service and UGM-84B for the UK version. Block 1B standard missiles were designated AGM/RGM/UGM-84C, Block 1C missiles AGM/RGM/UGM-84D, Block 1D missiles RGM-84F (cancelled before entering service), Block 1E missiles AGM-84E (also known as the Stand-off Land Attack Missile – SLAM), Block 1G missiles AGM/RGM/UGM-84G, and the SLAM-ER missiles are designated AGM-84H. Block 1J was a proposal for a further upgrade, AGM/RGM/UGM-84J Harpoon (or Harpoon 2000). for use against both ship and land targets. A revised design, Block 2, designated AGM/RGM/UGM-84L replaced Harpoon 2000, and this entered EMD in November 1998. This version uses the IMU navigation system from the JDAM guided bomb, and the INS/GPS from SLAM-ER.



An AGM-84H SLAM-ER missile displayed in 2002, with its wings and fins extended (Duncan Lennox) ***NEW***/0536213

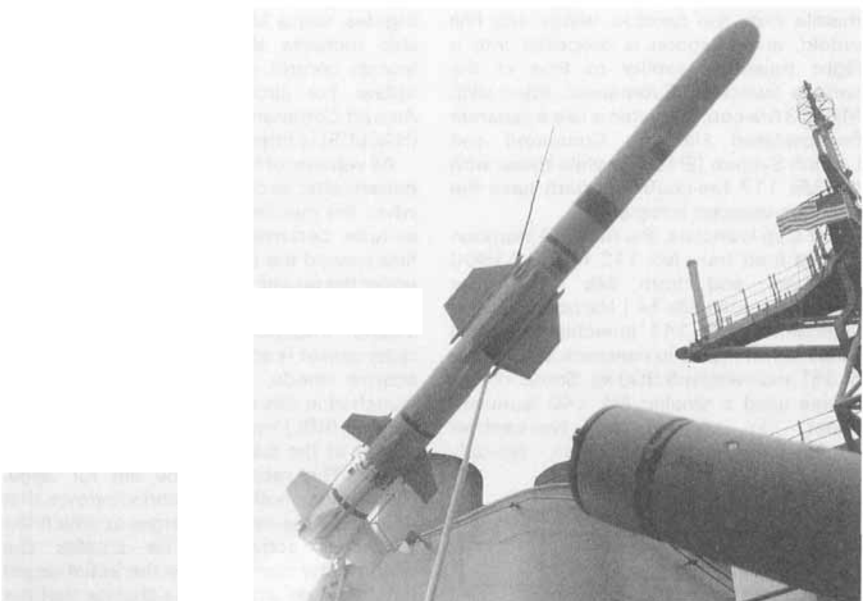
Proposals have also been made to fit wings and a new terminal seeker to the Block 2 design, known as Block 2 plus. A Block 3 version, with increased range, improved seeker and warhead was proposed in 1998, and in 2001 a proposal was made to adapt this version and the Block 2 for use with the Mk 41 VLS system.

A coastal defence system using the standard ship-launched RGM-84 missiles was also developed, and has been exported. The UK's UGM-84B version, with the RN designator GWS60, has been fitted to 'Trafalgar' and 'Swiftsure' class submarines and is launched through their torpedo tubes. This missile cruised at a lower altitude than the RGM-84A and a similar capability was introduced in the Block 1B missiles from 1982.

Block 1C missiles (AGM/RGM/UGM-84D) had improved ECCM, indirect attack and increased range, and entered service in 1984.

Block 1D missiles with further range and a re-attack capability were cancelled in 1993.

Block 1E missiles (AGM-84E SLAM) were developed to attack land targets and entered service in 1990. A naval version, known as RGM-84E Sea SLAM, was tested against a ship target in 1990, and against land targets in 1996. The Block 1G missiles have completed development and entered service outside the USA in 1997. It was planned to upgrade some US Block 1C missiles to the Block 1G standard with software improvements for ECCM and to provide a re-attack capability. The SLAM Expanded Response (SLAM-ER) AGM-84H introduces a new seeker and wings taken from the RGM/UGM-109 Tomahawk missile, and flight tests started in 1997. In 2000 it was reported that a dual-mode IIR/active radar seeker was in development for SLAM-ER, but in 2001 a XK seeker using DAMASK technology from the JDAM guided bomb with an uncooled focal plane array IR seeker was proposed. Additional fuel for longer range and a penetration warhead version of SLAM-ER were also proposed in 2001.



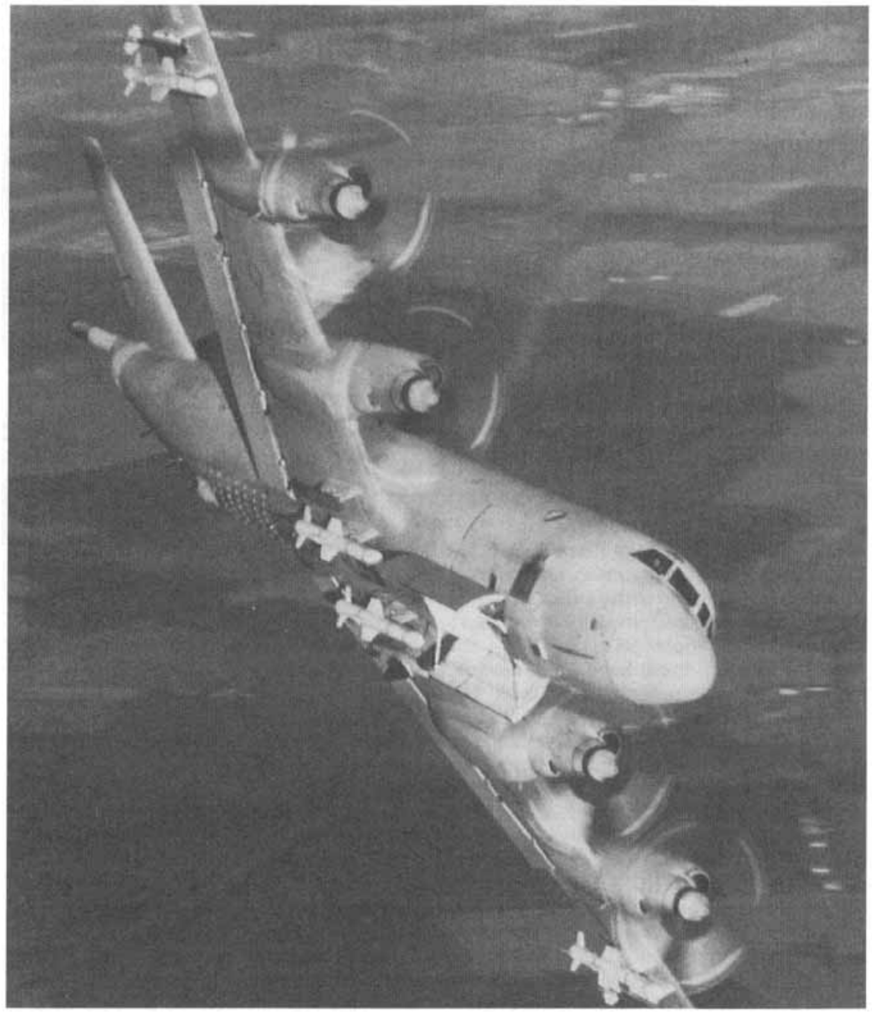
A Sea SLAM missile at launch, during trials at the US Naval Air Warfare Center Point Mugu in 7996 (USN AWC) *0008580*

Block 2 missiles have a land attack capability added, and will use the INS/GPS

from SLAM-ER with a HE blast/penetration warhead. The ships using this system will probably have an Advanced Harpoon Weapon Control System, which is considerably lighter and uses commercial software.

In 1994, McDonnell Douglas (now Boeing) proposed a further variant, named Grand SLAM, specifically aimed at a UK requirement for a 250 km range land attack missile, but this was not accepted.

The RGM-84 is fitted to guided missile cruisers of the 'Ticonderoga' class in two quadruple launchers; to guided missile destroyers of the 'Arleigh Burke', and 'Spruance' class in two quadruple launchers; and to the 'Oliver Hazard Perry' class of guided missile frigates, four missiles for a single launcher. UGM-84 missiles can be fitted to submarines of the 'Seawolf', 'Los Angeles', and 'Sturgeon' class for launch from their torpedo tubes. The AGM-84 Harpoon missile has been cleared for carriage on P-3 Orion, S-3 Viking, A-7E Corsair 2, Nimrod MR 2, F-16 Fighting Falcon, AV-8B Harrier 2, A-6 Intruder, B1-B Lancer, B-52 Stratofortress, F/A-18 Hornet, F-20 Tigershark aircraft, and the AGM-84E SLAM on B-52, F-111C, F27 Maritime, P-3 Orion, A-6 Intruder and F/A-18 Hornet aircraft. AGM-84H SLAM-ER has been cleared for carriage on F/A-18C/D Hornet and F/A-18E/F Super Hornet aircraft, and is planned for clearance on F-15E Fighting Eagle, B-1B Lancer, B-2A Spirit and B-52 Stratofortress.



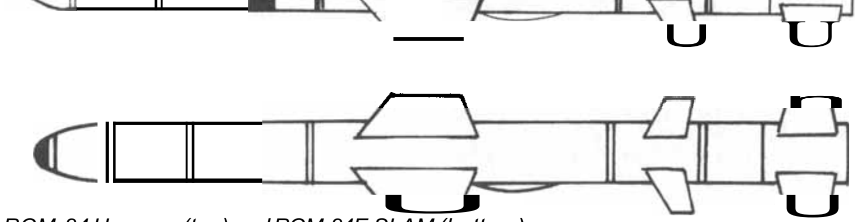
A US Navy P-3 Orion aircraft carrying four AGM-84 Harpoon missiles (US Navy)

Description

Harpoon has four clipped-tip triangular wings (folded on ship- and submarine-launched variants) at mid-body and four smaller in-line clipped triangular moving control fins at the rear. The missile with booster is 4.64 m long, has a body diameter of 0.34 m and with a 222 kg HE blast penetration warhead weighs 682 kg at launch. Both the UGM-84A and the RGM-84A are powered by a turbofan sustainer motor and have a tandem booster motor with in-line tail fins attached. The solid propellant boost motor burns for 3 seconds, and is then jettisoned. The turbofan engine has a fuel tank with 45 kg of fuel (JP-6 or JP-IO) with a 15-minute endurance. This combination gives the missile a maximum range of 130 km. For submarine launches, UGM-84 Harpoon is enclosed in a capsule. When launched from the torpedo tube, stabilising fins unfold to establish the proper glide angle for broaching the water's surface. A sensor then initiates release of the capsule nose and tail sections, followed by ignition of the missile boost motor. At the same time the missile exits the capsule, wings and fins unfold, and Harpoon is propelled into a flight trajectory similar to that of the surface launches. Submarines fitted with Mk 113 fire-control systems use a separate Encapsulated Harpoon Command and Launch System (EHCLS), while those with the Mk 117 fire-control system have the Harpoon weapon integrated.

For ship launches, the RGM-84 Harpoon can be fired from Mk 112 RUR-5 ASROC launchers and from Mk 10 Terrier launchers or the Mk 141 Harpoon canister launcher. A Mk 141 launcher assembly holds four missiles in canisters at an angle of 35" and weighs 5,900 kg. Some foreign navies used a smaller Mk 140 launcher, either in four- or two-canister configurations. Smaller ships, typically frigates, use a Mk 13 launcher. A ship fit also includes the AN/SWG-1 Harpoon launch control system plus surveillance radars. For aircraft carriage a Harpoon Aircraft Command Launch Control System (HACLCS) is fitted.

All variants of Harpoon fly the same flight pattern after aircraft or booster separation, when the missile descends to a low cruise altitude, determined by its altimeter, and flies toward the target by inertial guidance under the power of its turbofan engine. At a point preset by the launch platform the J-band frequency-agile two-axis active radar seeker is activated into its search and acquire mode. The missile is usually launched in this preset Range and Bearing Launch (RBL) mode, turning on the radar seeker at the last moment to acquire the target. The radar can be set for large, medium or small acquisition windows that determine the range-to-target at which the seeker is activated. The smaller the window the more precise the initial target data must be and the less chance that the missile will succumb to ECM. The alternative launch technique is the Bearing Only Launch (BOL) in which the missile is fired along the target bearing and the seeker is activated early in the trajectory to scan a 45° search sector either side of the missile course. If no target is acquired after a suitable time on the initial bearing then the missile switches to a preset search



RGM-84 Harpoon (top) and RGM-84E SLAM (bottom)

pattern and, if it then fails to acquire, it will self-destruct. In either launch mode, once the target is detected and the seeker is locked on in its tracking mode, the Block 1A missile climbs rapidly at about 1,800 m from the target in a pop-up manoeuvre before diving on to the target at an angle of about 30°.

The later Block 1B and 1C missiles have a sea-skimming terminal attack profile. The Block 1C can also be programmed to carry out an indirect approach. The improved RGM-84 Harpoon, known as Block 1D (not AGM-84E SLAM), was to have had the capability to conduct search patterns for targets, and was expected to have double the range of the RGM-84. This version was to be 5.3 m long and weigh 750 kg at launch, but Block I D was terminated in 1993. RGM-84G was introduced as Block 1G, which incorporates the software changes of the cancelled Block 1D but without extending the range. The coastal defence version of Harpoon uses a wheeled transporter-erector-launcher vehicle carrying four missiles in canisters. A basic system consists of a missile control unit vehicle and two TELs, with the control unit assemblies using the same command launch control system as on board ship.

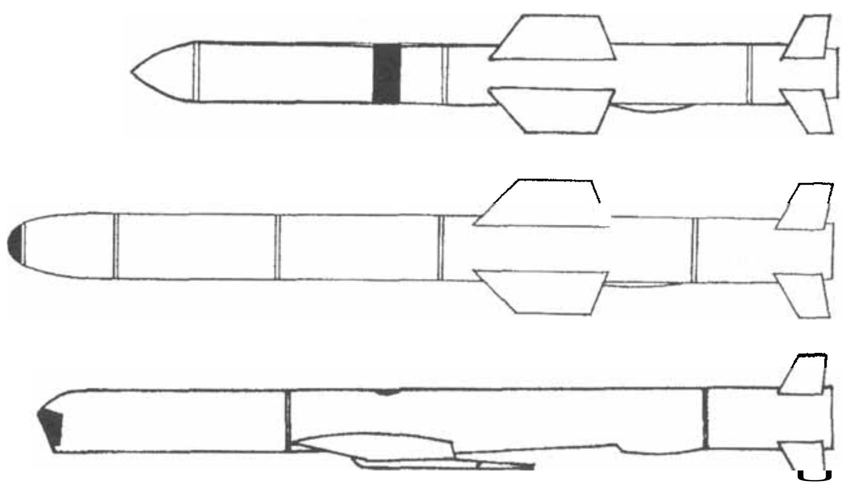
AGM/RGM/UGM-84L Harpoon Block 2 (was Harpoon 2000) is being developed for land attack as well as anti-ship use. It is expected to include SLAM software, with a ring laser gyro inertial measurement unit from the JDAM guided bomb, and an INS/GPS from SLAM-ER providing a CEP of around 10 m against land targets. This version will use the 222 kg HE blast penetration warhead. Upgrade kits to modify Block I C missiles will be produced for the US Navy and export. An Advanced Harpoon Weapon Control System may be fitted to ships and submarines, saving 650 kg in weight, introducing automated mission planning with waypoints, boost motor drop areas and flight corridors. Later versions of the Block 2 missiles may be adapted for launch from the Mk 41 VLS.

The AGM-84E SLAM uses the Harpoon airframe, engine and warhead with an AGM-65D Maverick IIR seeker and an AGM-62 Walleye AN/AWW-14 video datalink pod to enable the aircrew to control the seeker. SLAM has inertial mid-course guidance updated by GPS. The missile (air-launched version) is 4.50 m long, has a body diameter of 0.34 m, and weighs 628 kg at launch. This version has a maximum range of 95 km. Automated mission planning was introduced in 1996.

In 1998 trials started using just GPS guidance with SLAM, indicating a reasonable accuracy without having to maintain a datalink to the launch aircraft. A possible US Navy version will be known as RGM-84E Sea SLAM, and this missile will be 5.25 m long (including the Harpoon boost motor assembly), and weigh 780 kg at launch. Sea SLAM will need a fixed-wing aircraft (F/A-18 Hornet) or helicopter (SH-60 LAMPS) as an airborne datalink for maximum range firings. This missile might carry a unitary warhead or eight BAT or 153 CEM submunitions. The terminal IIR seeker is used to enable the aircrew to select its aim-point, and lock the missile guidance on to that aim-point so that the launch aircraft can manoeuvre away from any defences. The maximum range of Sea SLAM is 85 km.

AGM-84H (SLAM-ER) introduces an improved IIR seeker and adds wings derived from the RGM/UGM-109 Tomahawk missile with a span of 2.18 m. This increases the range to 280 km. The missile has a length of 4.37 m, a body diameter of 0 34 m and a launch weight of 680 kg This version has a 247 kg HE blast penetration warhead, WDU-40/B, developed from the titanium case Tomahawk missile warhead, and an FMU-155/B fuze with three delay settings The missile mid-course guidance uses INS/GPS positional data and digital stored

A four-canister Mk 141 RGM-84 Harpoon missile launcher on a 'Baleares class frigate (van Ginderen Collection) 0038275



*AGM-84 Harpoon **(top)**, AGM-84E SLAM (middle) and AGM-84H SLAM-ER (bottom)*
NEW/0121197

An RGM-84L Harpoon missile displayed at Farnborough in 2000 (Duncan Lennox)
0093553

terrain elevation data, combined to provide cruise altitude demands to the missile, looking ahead of the flight path by some 10 km. SLAM-ER uses an improved video datalink between the missile and launch aircraft, with the IIR seeker switched on around 60 seconds before impact at the target. The seeker locks onto the target at between 10 and 5 km range, using image correlation algorithms, and the picture can be frozen for two seconds using the Stop Motion Aimpoint Update (SMAU) system. SMAU allows the operator to freeze the video picture and designate the precise land or ship target for the terminal phase guidance. The seeker can target moving ships, and the datalink can also be used for battle damage assessment. The IIR seeker has automatic target acquisition using optical correlation between a stored photograph and the seeker output. The accuracy is reported to be around 3 m CEP.

An improved mission planning system reduces the time required from several hours to less than 30 minutes. Future improvements being considered for SLAM-ER include a larger penetration warhead and automatic target acquisition, the latter matching computer-stored photographic images with the IIR seeker images to locate and track the designated target.

Operational status

The first Harpoon missile trial flight was completed in 1972, and three versions of Harpoon entered service in 1977. The air-, ship- and submarine-launched versions and missiles have been produced for the US Navy and many other countries. Block 1B missiles entered service in 1982, Block 1C in 1984, Block 1D was terminated in 1993, Block 1E entered service in 1990 (SLAM) and Block 1G was exported from 1997.

The Harpoon missile remains in production with the rate in 2001 at around 100 missiles per year and, by the end of 2001, over 7,300 missiles (Harpoon, SLAM and SLAM-ER) had been ordered with over 3,700 for export. Harpoon is used by the following countries: Australia, Bahrain, Brazil, Canada, Denmark, Egypt, Germany, Greece, Indonesia, Iran, Israel, Japan, South Korea, Kuwait, Malaysia, Netherlands, Oman, Pakistan, Poland, Portugal, Saudi Arabia, Singapore, Spain, Taiwan, Thailand, Turkey, United Arab Emirates, UK, USA and Venezuela. AGM-84 and RGM-84 Harpoon missiles were used against targets in Libya in 1986, by Iran in 1986-88 against Iraq, by the USA against Iran in 1988 and against Iraq in the 1990-91 Gulf War. The first use of AGM-84H SLAM-ER was reported against a target in Iraq in December 1999.

AGM-84E SLAM entered service in 1990, and was used in the 1990-91 Gulf War when about seven missiles were fired. By June 1996, there had been approximately 600 SLAM missiles delivered for use by the USAF, when production finished. A test flight was made in September 1998 with SLAM being guided just by GPS, with a successful flight to a range of 80 km. Original plans were that the USAF would purchase 900 SLAM, but this figure was reduced to introduce the SLAM-ER version.

AGM-84H SLAM-ER started flight tests in March 1997 and a 15-missile test programme was completed in 1999. Plans announced in 1995 indicated that some SLAM missiles will be upgraded and some SLAM-ER new built to reach a total of 700 SLAM-ER by 2004. Low-rate initial production for 60 missiles started in 1997, and a further 22 missiles were ordered in 1998. A total of 187 LRIP missiles has now been ordered and full-rate production was authorised in May 2000 for 346 upgrade kits.

In 2002 South Korea requested the order of SLAM-ER missiles for fitting to their new F-15 K aircraft. An improved SLAM-ER will have automatic target acquisition and 22 upgrade kits were ordered in 1998, to carry out a six flight evaluation programme. The first flight was made in December 2000. The RGM-84E Sea SLAM proposal, was tested against a ship target in 1990, using an SH-60 Seahawk helicopter to designate the target, and two missiles were launched in April 1996 against land targets, with designation from an SH-60 helicopter for the first trial and from an F/A-18 Hornet in the second trial.

RGM-84G (Block 1G) missiles completed flight tests in 1997 and deliveries started to overseas customers. It is expected that some USN Block 1C missiles may be upgraded to the Block 1G standard. Upgrade kits to modify up to 950 Block 1C missiles to the Block 2 AGM/RGM/UGM-84L standard are expected to be ordered by the US with deliveries starting around 2003. The first flight test of the Block 2 missile was made in June 2001 against a ship target, and a second test was made in August 2001 against a land target. Three flight tests were made in October 2001 against land and ship targets. Denmark ordered the first Block 2 missiles for export, and these have been upgraded from Block IC missiles, with the first 50 kits delivered in April 2002. Further Block 2 missiles have been ordered by the United Arab Emirates (12 missiles) and Egypt (53 missiles), but the Egyptian missiles will not have a land attack capability.

Coastal defence systems, using the standard RGM-84 Harpoon ship-launched missile system, have been ordered by Denmark, Egypt and Spain. Denmark has two batteries of missiles, using Block IC, with each battery having two launcher vehicles, each fitted with four launch canisters.

Specifications

RGM/UGM-84 Harpoon
Length: 4.64 m
Body diameter: 0.34 m
Launch weight: 682 kg
Payload: Single warhead; 222 kg
Warhead: HE blast penetration
Guidance: Inertial and active radar
Propulsion: Turbofan
Range: 130 km
Accuracy: n/k

AGM-84 Harpoon
Length: 3.85 m
Body diameter: 0.34 m
Launch weight: 556 kg
Payload: Single warhead; 222 kg
Warhead: HE blast penetration
Guidance: Inertial and active radar
Propulsion: Turbofan
Range: 120 km
Accuracy: n/k

AGM-84E SLAM
Length: 4.50 m
Body diameter: 0.34 m
Launch weight: 628 kg
Payload: Single warhead; 222 kg
Warhead: HE blast penetration
Guidance: Inertial with GPS and IIR
Propulsion: Turbofan
Range: 95 km
Accuracy: n/k

AGM-84H SLAM-ER
Length: 4.37 m
Body diameter: 0.34 m
Launch weight: 680 kg
Payload: Single warhead; 247 kg
Warhead: HE blast penetration
Guidance: Inertial with GPS and IIR
Propulsion: Turbofan
Range: 280 km
Accuracy: n/k

Contractor

Boeing Military Aircraft and Missile Systems, St Louis, Missouri.

AGM-86 ALCM/CALCM

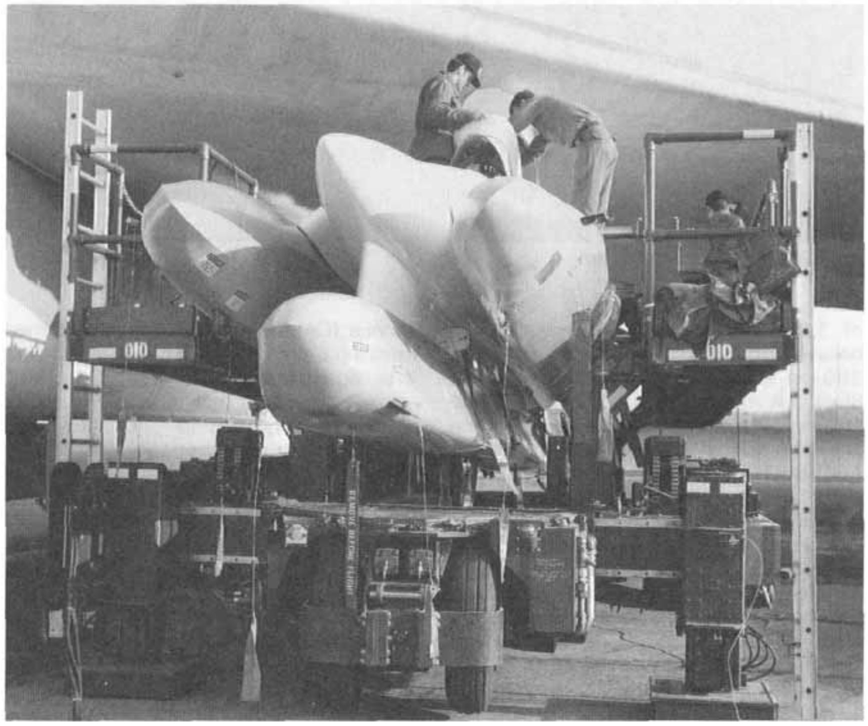
Type

Intermediate-range, air-launched, turbofan-powered, single-warhead cruise missiles.

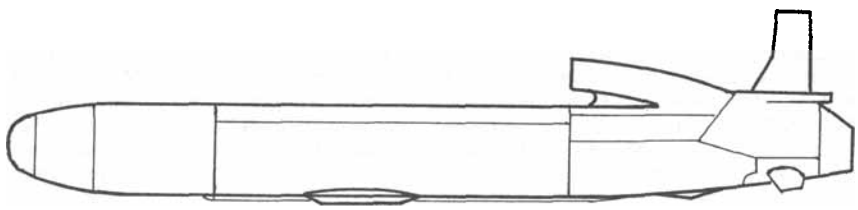
Development

Feasibility studies for a strategic nuclear Air-Launched Cruise Missile (ALCM) had been in progress since the late 1960s and the Subsonic Cruise Armed Decoy (SCAD) became the favoured solution by 1970. In 1973, the US Air Force turned SCAD into ALCM and the competition from the US Navy's SLCM programme helped to get ALCM work additional funding. By 1976 the programme was in development and the first powered flight was made in the same year. Development continued through the 1970s and the AGM-86 entered service in 1982. An earlier design, designated AGM-86A, had a smaller body and greater wing sweep but was not put into production. The AGM-86B was 2 m longer, 550 kg heavier and had a greatly increased range. A conventional HE warhead version was developed in the 1980s. known as AGM-86C, the Conventional Air-Launched Cruise Missile (CALCM). Boeing completed a study to upgrade AGM-86B by installing a propfan engine in place of the turbofan, increasing range by 25 per cent. This proposal was one of several aimed at providing a Conventional Cruise Missile (CCM) to meet the joint USAF/USN requirement for a Long-Range Conventional Standoff Weapon (LRCSOW); however, this requirement was cancelled in 1991. AGM-86B missiles were taken out of service from 1992, and some have been modified to the AGM-86C standard, with HE blast/fragmentation warheads and the addition of GPS receivers. Unconfirmed reports indicate that bulbous EMP warheads have been tested, together with coatings of RAM paint to reduce the radar cross-section. Reports in 1994 suggested that AGM-86B missiles could be converted into ALCM-RC reconnaissance vehicles, and it is also reported that some AGM-86B missiles have been converted into air-launched decoys carrying ECM, chaff and IR flares. A CALCM (AGM-86C) Block 1 upgrade was delivered in 1996, with improved GPS guidance and an upgraded blast/fragmentation warhead. A second upgrade, to Block 1A standard, was started in 1998, including eight-channel GPS receivers with anti-jamming capability and improved navigation software.

A proposal for CALCM Block 2 (AGM-86D) was made in 1996, changing the warhead to a dual-charge penetrator for use against hard and deeply buried targets. US AUP-3M (Lockheed Martin) and UK (BROACH) 400 kg warhead designs were tested and, in 1999, the AUP-3M warhead was selected. It is also reported that the Block 2 upgrade will include eight-channel GPS receivers to reduce the CEP to between 3 and 5 m, and that UAVs may be used to provide target updates for the missiles. A new-build AGM-86E has been proposed, following the large number of CALCM used in operations during 1998 and 1999.



The front three ALCM of a six-missile pylon load, being attached to a USAF B-52G bomber



AGM-86C **missile**

The new-build missiles have been called CALCM-ER, and would have new electronics, new motors and a range increased to between 2,500 and 3,000 km.

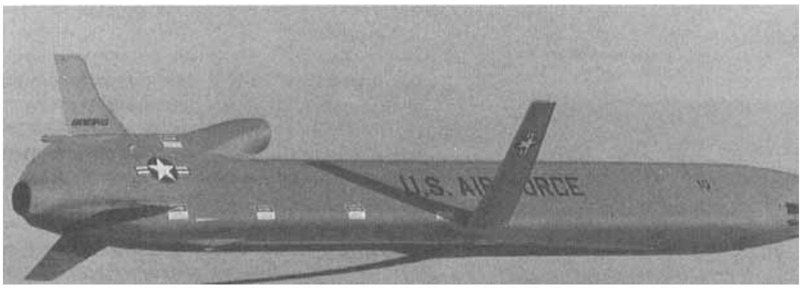
In 2002 plans were announced to extend the service life of AGM-86 missiles to 2030, including some nuclear AGM-86B missiles. A thermobaric warhead is being developed by the USAF, and this may be fitted to AGM-86C or CALCM-ER missiles in the future for use against deeply buried bunkers or cave targets.

AGM-86B/86C are carried by the B-52H Stratofortress, with six under each wing and an additional eight missiles on a rotary launcher in the bomb bay. The B-1B Lancer carries eight missiles internally and 14 under the fuselage. It is believed that 48 aircraft of the B-52H fleet will be retained as nuclear ALCM (AGM-86B) and AGM-129 carriers, with the B-1B not carrying AGM-86 missiles. AGM-86C may be cleared for carriage on the B-2A Spirit bomber, with up to five missiles carried internally.

Description

The AGM-86B has two swept-wings mounted under the mid-body with moving control tailplanes and a fixed fin at the rear. The engine air inlet is on top of the body, just in front of the fin. When carried under, or in, aircraft the flying surfaces are folded around the missile body. The missile is 6.32 m long, has a body diameter of 0.69 m, an extended wing span of 3.65 m and weighs 1,458 kg. Guidance is inertial, updated by a map-matching technique called TERCOM (terrain comparison). The low-altitude flight profile is maintained by a radar altimeter. Correlation of the sampled terrain elevation contours with the digital map data provides the inertial system with a position update at selected points during the flight. AGM-86B has a Williams F-107-WR 101 turbofan engine weighing 66 kg and operating on JP-9 fuel. The warhead is a nuclear W80-1 in the 200 kT range, reported to have selectable yields between 5 and 200 kT. The CEP is reported as 30 m. This subsonic missile has a maximum range reported as 2,500 km.

It is reported that the HE warhead AGM-86C version has a GPS receiver to replace the Tercom guidance. AGM-86C is believed to be similar in size to AGM-86B, but with a 910 kg HE blast/fragmentation warhead containing steel balls, and a launch weight of 1,750 kg. The range is reported to be reduced to 1,320 km. with an accuracy of 15 m CEP. The Block 1 upgrade version has a larger warhead with a weight of 1,360 kg, and a launch weight



An AGM-86B missile in flight

of 1,950 kg. The Block 1 missiles are believed to have a maximum range of 950 km, and an accuracy of 5 m CEP. The Block 1A missiles have an eight-channel GPS receiver with improved anti-jamming capability and an accuracy of 3 m CEP. The AGM-86D missile has an AUP-3M (BLU-116/B) penetration warhead, and this is 2.4 m long, has a diameter of 0.37 m, a weight of 545 kg and contains 43 kg of HE. The warhead is initiated by a hard target smart fuze, which can count the voids between floors and explode the warhead deep inside a hardened building. The maximum range of the AGM-86D is believed to be 1,320 km.

Operational status

AGM-86B ALCM entered service with the USAF in 1982 and some 1,715 missiles were built between 1982 and 1986. The programme was terminated early as over 3,000 missiles were to have been procured and funding was diverted into the AGM-129 Advanced Cruise Missile programme. In 1988, the AGM-86C conventional HE warhead version entered service (CALCM), and 35 were launched from B-52 aircraft during the 1990-91 Gulf War against Iraq, and again in 1996 against targets in Iraq when 16 missiles were launched. Some 90 AGM-86C missiles were launched against Iraq in December 1998, and around 230 were used against targets in Serbia and Kosovo in 1999. It is reported that AGM-86B nuclear warheads are being replaced by non-nuclear EMP warheads on some missiles, that some missiles have been converted into air-launched decoys, and there is also a proposal to modify some into reconnaissance UAVs. It is believed that 200 ALCM had been converted to the AGM-86C standard by the end of 1997. Approval was given in 1998 for a further 92 missiles to be converted, and a second request was made in 1999 for another 230 missiles to be converted.

In January 2002 it was believed that there were 1,140 AGM-86B/C/D missiles in service, with 200 to 400 nuclear warhead AGM-86B, in long-term storage. Around six missiles are tested each year. The recent modification programmes were to upgrade 140 missiles to the AGM-86C Block 1 standard, 339 missiles to the AGM-86C Block 1A standard, and 50 missiles to the AGM-86D (Block 2) standard, fitted with AUP-3M penetration warheads. It is believed that 150 AGM-86D missiles are planned for the USAF. Operational evaluation of the Block 1A missiles started in May 2001, and the first live warhead test for an AGM-86D was made in November 2001. There have been no reported exports of any AGM-86 missiles.

Specifications

AGM-86B
Length: 6.32 m
Body diameter: 0.69 m
Launch weight: 1,458 kg
Payload: Single warhead; 450 kg
Warhead: Nuclear 200 kT
Guidance: Inertial with tercom
Propulsion: Turbofan
Range: 2,500 km
Accuracy: 30 m CEP

AGM-86C/D
Length: 6.32 m
Body diameter: 0.69 m
Launch weight: 1,750 kg (Block 0), 1,950 kg (Block 1)
Warhead: HE blast/fragmentation; 910 kg (Block 0), 1,360 kg (Block 1), 545 kg HE penetration (Block 2)
Guidance: Inertial with GPS
Propulsion: Turbofan
Range: 1,320 km (Block 0 and 2). 950 km (Block 1)
Accuracy: 15 m CEP (Block 0), 5 m CEP (Block 1), 3 m CEP (Block 1A)

Contractor

Boeing Military Aircraft and Missile Systems, St Louis, Missouri.

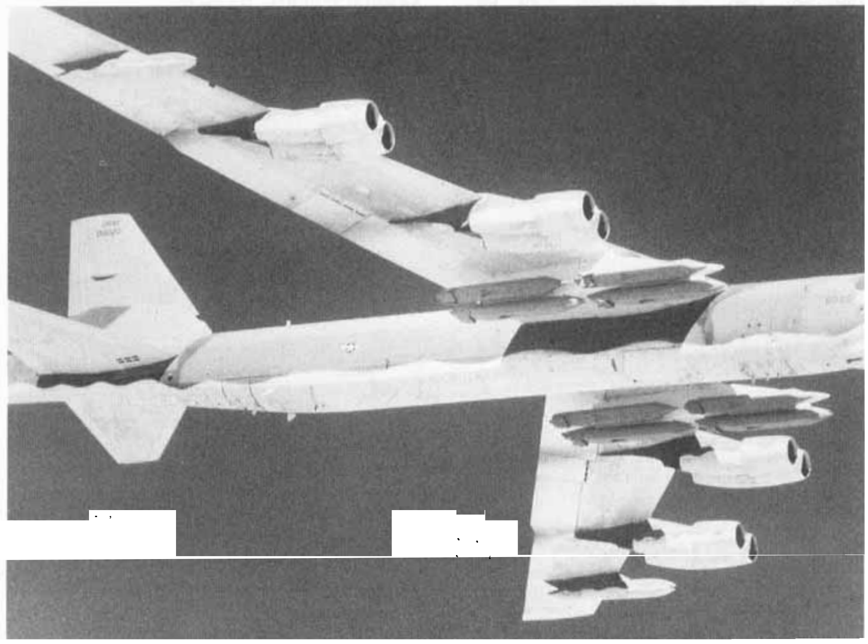
AGM-129 ACM/CACM

Type

Intermediate-range, air-launched, turbofan-powered, single-warhead cruise missile.

Development

The AGM-129A Global Shadow nuclear warhead Advanced Cruise Missile (ACM) entered development in 1983 with a contract won by General Dynamics (Hughes Missile Systems and now Raytheon Missile Systems). Originally a 'black' programme in the USA known as Teal Dawn, the missile uses a stealth structure with distinctive swept forward wings. This missile was planned as a replacement for the AGM-86 ALCM and to have longer range, improved accuracy, lower radar cross-section and lower infra-red signature. The AGM-129B was being developed in the late 1980s with a modified structure, software changes and a conventional warhead using a unitary HE warhead or submunitions; but the programme was terminated. Reports in 1997 suggested that a new version, designated AGM-129C Conventional Armed Cruise Missile (CACM), might be developed. The modifications were to have included differential GPS and a penetration warhead, but would have resulted in a considerably reduced maximum range. In 2001 a mid-life upgrade programme was proposed, to provide a life extension until 2030. The AGM-129A is designed for carriage on the B-52H Stratofortress, B-1B Lancer and B-2A Spirit bomber aircraft, but it is believed that 48 of the B-52H fleet will be retained as the sole AGM-129A carriers, although a non-nuclear AGM-129C might be carried on the B-1B and B-2A aircraft as well. It is believed that the B-52H can carry eight AGM-129 missiles on internal rotary launchers and a further 12 missiles on underwing pylons.



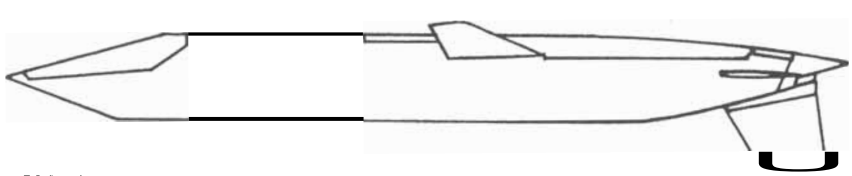
A B-52 Stratofortress carrying eight AGM- 129 nuclear cruise missiles on underwing pylons (USAF) 0008584

An AGM-129A missile in flight, showing the swept forward wings and the painted wedge nose shape

Description

AGM-129A has a flattened body shape with pointed wedge nose, a flat wedge tail section, forward-swept wings above the centrebody, a folding vertical fin and folding tailplanes. The missile is 6.35 m long, has a body height of 0.64 m and a body width of 0.70 m. When extended the wings have a span of 3.1 m. The launch weight of the missile is 1,590 kg. It is reported that AGM-129 has inertial mid-course guidance with laser doppler velocity meter and radar altimeter terrain contour matching waypoint updates. The missile has a laser radar terminal phase guidance system. A Williams International F112-WR-100 turbofan engine provides the propulsion, and the engine inlet is located under the missile body just behind the wings, with the exhaust nozzle in the flat wedge tail assembly. The engine has a thrust of 335 kg. It is believed that the W80-1 nuclear warhead yield is in the 200 kT range with selectable yields from 5kT up to 200 kT, and has a weight of 135 kg. The AGM-129A missile has a maximum range believed to be around 2,500 km.

The proposed AGM-129C CACM missile is reported to include improved differential GPS and an HE penetration warhead. The considerably greater warhead weight would probably reduce the maximum range to around 1,500 km. It is believed that any CACM to be produced would be modified from existing AGM-129A missile stocks.



AGM-129 missile

Operational status

The AGM-129A ACM started development in 1983 and entered service in 1991. A 22-flight development test programme started in 1985, and was completed in 1990. Eight further evaluation flights were carried out in 1991. McDonnell Douglas (now Boeing) was awarded a contract in 1987, to qualify as a second source producer of ACM. It was expected that around 1,000 missiles, 880 nuclear and 120 conventional HE variants, would be required by the USAF, but the total was reduced to 640 missiles in 1992 and to 460 nuclear weapons in 1993. Production was completed in 1993. Proposals were

made in 1997 for an AGM-129C CACM version, with an initial order for 20 to 30 trials missiles expected but, in 2000, it was reported that this proposal had been dropped. Around five missiles are flight tested each year. It is believed that the missiles are stored at Barksdale AFB, Louisiana, and at Minot AFB in North Dakota.

Specifications

Length: 6.35 m
Body diameter: (h × w) 0.64 × 0.70 m
Launch weight: 1,590 kg
Payload: Single warhead
Warhead: Nuclear 5 to 200 kT
Guidance: Inertial with laser radar
Propulsion: Turbofan
Range: 2,500 km
Accuracy: n/k

Contractor

Raytheon Missile Systems, Tucson, Arizona.

AGM-130

Type

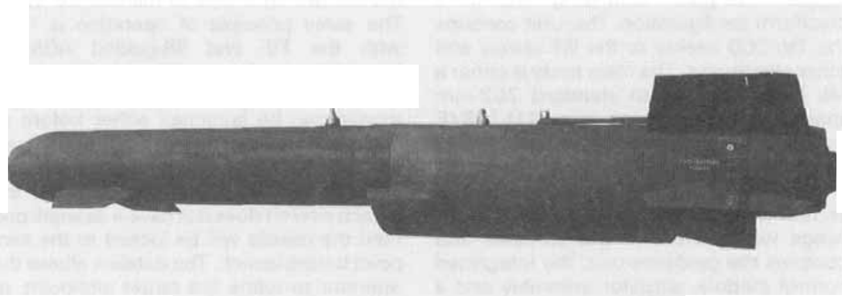
Short-range, air-launched, solid-propellant, single-warhead air-to-surface missile.

Development

In 1984, a full-scale development contract was placed by the US Air Force with Rockwell International (now Boeing) for a powered version of the GBU-15 modular glide bomb. The requirement was to give the GBU-15 a better performance and a greater standoff range at low cost, and was similar to the development of the AGM-123A Skipper 2 (from GBU-I6 Paveway 2). Narrower cord and rectangular front and rear wings were produced for the new missile, designated AGM-130 and, in order to reduce costs, these were also adopted by later production models of the GBU-15. Flight test and evaluation of the prototype AGM-130 took place during the mid-1980s and an early production contract was placed in 1990. Originally, there were three versions studied; AGM-130A with a Mk 84 general purpose bomb as its warhead, AGM-130B with an SUU-54 dispenser as its warhead, and AGM-130C with a BLU-109 penetration bomb as its warhead. It was reported in 1986 that a development contract was let to provide a jam-resistant datalink system and that trials had been carried out using a fibre optic cable.

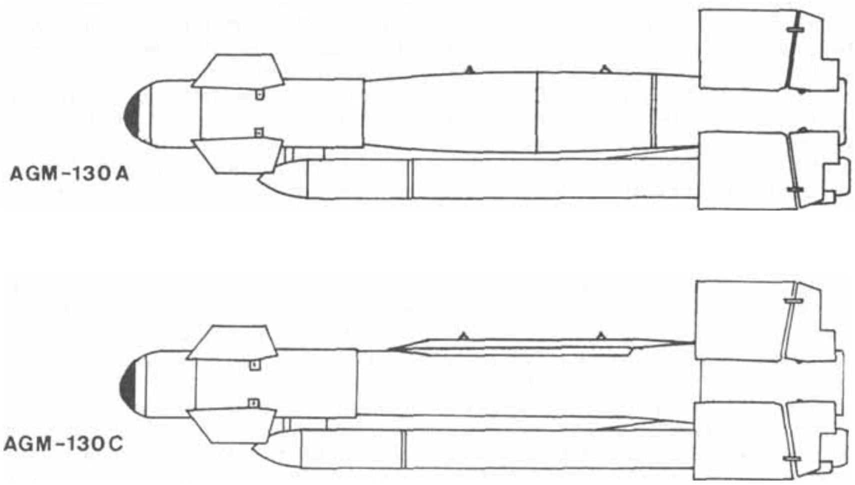
In 1987, the AGM-130B and AGM-130C versions were put on hold, but the AGM-130C was restarted in 1991 as a hard target penetration weapon programme using the 1-2000 or BLU-109/B warheads. Also in 1991, a development contract was let by the USAF for a new Charge Coupled Diode (CCD) TV camera for AGM-I30, as well as studies for a turbojet-powered, longer-range variant incorporating inertial guidance and GPS for mid-course correction. Two provisional designs, designated AGM-130E, were proposed in 1993 as long-range variants; a 1,360 kg design using a BLU-109/B warhead and a 910 kg design using a Mk 83 warhead. These designs featured turbojet propulsion, INS/GPS navigation and other guidance improvements, but were put on hold.

In 1993, the USAF funded a design improvement programme to introduce an integrated GPS and inertial measurement unit to AGM-130A/C versions to reduce operator workload in mid-course, and to continue to reduce both production and in-service costs for the guidance assemblies. The USAF requirement for a Silent Hard Kill (SHARK) missile to attack non-radiating radars could be met by an upgraded AGM-130 variant and, in 1994, studies were reported to have started. In 1996, a hard target attack programme was started for AGM-130, with the missile launched from high altitude and then making a steep 70° dive on to the target. Flight trials started in 1997 with an AGM-130C version fitted with the BLU-109/B penetration warhead and a Honeywell-developed inertial measurement unit taken from the JDAM guided bomb programme.



Full size prototype model of the 1993 proposed AGM-130E turbojet-powered missile (Boeing)

AGM-730A missile snowing the cylindrical solid-propellant motor attached beneath the adapted Mk 84 bomb main body section (Boeing) 0038277



AGM-130A (above) and AGM-130C (below)

It is expected that the hard target penetration modifications will be introduced by retrofit kits to a limited number of in-service missiles.

A 200 km variant of AGM-130E, with a TV (CCD)/IIR dual-mode seeker, was offered in 1995 to fulfil the UK's CASOM requirement, but was not selected. In 1997, Boeing proposed examining a laser terminal seeker version for AGM-130 and adding an automatic target recognition capability to the IIR seeker version. In 1998 Boeing tested a private venture programme with a further variation of AGM-130E, using a turbojet engine and a lighter 1-1000 (454 kg) warhead. This missile will have inertial and GPS guidance, will cruise at M0.85, and have a range of 165 km. The launch weight will be 1,075 kg. light enough to be carried by the F-16 Fighting Falcon aircraft.

The AGM-130 has been cleared for carriage on the F-4E Phantom, F-15E Eagle and F-111F Raven aircraft, and has been proposed for fitting to the B-1B Lancer and a lightweight AGM-130 version to the F-16 Fighting Falcon.

Description

The AGM-130A/C missiles are basically a Mk 84 general purpose bomb or a BLU-109/B penetrating bomb respectively fitted with a TV or IIR seeker head, a GBU-15 short chord aerofoil group, and a solid-propellant motor. They are made up of four major assemblies: the front

guidance seeker section which is cylindrical in shape, has a dome-shaped glass nose and four fairly large, fixed clipped triangular stabilising fins in a cruciform configuration. This unit contains the TV/CCD seeker or the IIR seeker and other electronics. The main body is either a Mk 84 warhead with standard 762 mm spaced suspension lugs or a BLU-109/B warhead which, because of its smaller body diameter, requires a hard saddleback to carry the suspension lugs. The rear end control section has four in-line rectangular wings with eleven control surfaces and contains the guidance unit, the integrated control module, actuator assembly and a tail-mounted datalink. There is an external strake running between front and rear units. Attached beneath the missile's body and running along almost its entire length is an Alliant Techsystems SR 122-RD-1 solid propellant boost motor. The motor is 2.89 m long, 228 mm diameter, and cylindrical in shape. The motor is jettisoned during flight, on completion of the 60 second boost phase. Both TV- and IIR-guided versions of the AGM-130A are 3.94 m long, have a maximum body diameter of 0.46 m, a rear wing span of 1.50 m and weigh 1,323 kg.

The Mk 84 general purpose bomb warhead contains 428 kg of Tritonel or H-6 explosive and uses the FMU-124A/B fuzing system which is fitted at the rear of the warhead. Both TV- and IIR-guided versions of the AGM-130C are 3.95 m long, have a body diameter of 0.37 m, a rear wing span of 1.50 m and weigh 1,353 kg. The BLU-109/B bomb has a weight of 874 kg, is a penetrating warhead that contains 240 kg of Tritonel or PBXN-109 explosive, and uses either the FMU-143/B, MFBF, FEU 80, JPF or HTSF fuzing systems fitted at the rear of the warhead. Mid-course guidance for AGM-130A/C missiles is inertial but an upgrade has been developed using a dual INS/GPS module. Terminal guidance is by means of either the television or IIR nose-mounted seeker in the missile, transmitting a picture by datalink to the launch aircraft. The IIR seeker has a 256 × 256 cadmium mercury telluride staring focal plane array, and is interchangeable with the TV charge coupled device camera assembly. The datalink is the AXQ-14 system, developed for use with the GBU-15, and the launch aircraft carries a datalink pod. An improved datalink has been developed, and is believed to have entered service in 1998. The weapons operator selects an aim-point on his cockpit display and designates that point to the missile, from which time the launch aircraft is free to manoeuvre away. The same principle of operation is used with the TV- and IIR-guided AGM-65 Maverick missiles, and it is believed that AGM-130 uses the Maverick seekers. The missile can be launched either before or after locking on to a target, or alternatively can be manually steered by the aircraft operator all the way to the target. If the launch aircraft does not have a datalink pod then the missile will be locked to the aim-point before launch. The datalink allows the operator to refine the target aim-point, or even to abort the attack if the wrong target has been selected. For the upgraded missiles with the INS/GPS navigation unit, AGM-130 can be launched from above cloud and without any terminal guidance.

The AGM-130 has a radar altimeter and digital guidance system allowing a flight trajectory to be reprogrammed from the normal glide-boost-glide profile before launch. The missile cruises at an altitude of 600 m and then descends to 300 m for the terminal phase, finally diving on to the designated target. The missile has a maximum range, when launched from a medium (30,000 ft) altitude, of 45 km.

The long-range, turbojet-powered, AGM-130E, proposed in 1993, had two planned missile configurations. A 900 kg version that would have had a Mk 83 bomb as its warhead, and a 1,360 kg version which would have had a BLU-109/B penetrating bomb as its warhead. They would have had cylindrical bodies with rounded, glass-domed nose sections with two clipped triangular, slightly anhedral stabilising fins and, at the rear, conventional aircraft-type horizontal tailplane surfaces as well as a 'V tail. Beneath the rear half of the missile body was a flared-in turbojet engine with both air inlet and exhaust below the level of the missile's body.

The new version AGM-130E, tested in 1998, has a lighter 1-1000 warhead with a weight of 454 kg, believed to be similar to the warhead planned for AGM-158 JASSM. The missile will have a launch weight of 1,057 kg. A turbojet engine will provide a cruise speed of M0.85 and a maximum range of 165 km. The engine mounting appears to be different from the 1993 designs, in that the engine is pod mounted below the missile body. Guidance will be by a combined INS/GPS navigation system, with the terminal guidance by interchangeable TV or IIR seekers.

Operational status

Full-scale development of the modifications and additions to the GBU-15 started in 1984. The USAF placed an early production order for 28 AGM-130A missiles in 1990, followed by a second order for 48 missiles in 1991 and 120 in 1992 for flight tests, training and production qualification. In 1994, it was reported that the USAF had about 140 AGM-130 missiles in stock, equipped with TV and IIR seekers, and that the total requirement was for 1,000 missiles. The total requirement was then reduced to 400, which was subsequently increased to 674. In June 1999 it was believed that around 500 missiles had been delivered to the USAF. It is reported that the production line remains open, and the numbers could increase still further if it is decided to equip other aircraft. In 1996, South Korea ordered 116 AGM-130 missiles for use from its F-4E Phantom aircraft. AGM-I30 missiles were used operationally in Iraq from January 1999, and against targets in Serbia and Kosovo from March to June 1999.

Specifications

AGM-130A
Length: 3.94 m
Body diameter: 0.46 m
Launch weight: 1,323 kg
Payload: Single warhead
Warhead: Mk 84 bomb
Guidance: INS/GPS with TV or IIR
Propulsion: Solid propellant
Range: 45 km
Accuracy: n/k

AGM-13QC
Length: 3.95 m
Body diameter: 0.37 m (0.46 m with hardback)
Launch weight: 1,353 kg
Payload: Single warhead
Warhead: BLU-109/B bomb
Guidance: INS/GPS with TV or IIR
Propulsion: Solid propellant
Range: 45 km
Accuracy: n/k

Contractor

Boeing Military Aircraft and Missile Systems, St Louis, Missouri. (prime contractor).

AGM-158 JASSM

Type

Short-range, air-launched, turbojet, single-warhead cruise missile.

Development

A replacement was required for the cancelled AGM/MGM-137 TSSAM programme in 1995, and a joint USAF/USN project started in 1996 with the award of two project definition contracts to McDonnell Douglas (now Boeing) and Lockheed Martin. The new missile, designated AGM-158, is known as the Joint Air-to-Surface Stand-off Missile (JASSM) and, in April 1998, the Lockheed Martin team was selected to continue into a 40-month engineering and manufacturing development programme that started in November 1998. The requirement was for a low-cost, stealthy, land-attack cruise missile, with a range believed to be 500 km. An improved missile was proposed by Lockheed Martin in 1999, with a range increased to 2,500 km and armed with a 500 kg class penetration warhead similar to the AUP-3M warhead selected for the AGM-86D. Other proposals include fitting submunitions such as LOCAAS, or developing an incendiary-type warhead for use against chemical and biological weapon storage areas. An advanced concept technology demonstration programme, called 'Dipole Yukon', will test JASSM with a special warhead to destroy chemical and biological facilities in tests during 2002/2003.

A Block 1A missile with an improved IIR seeker and an anti-jam GPS receiver is being developed, and the first demonstration flight was made in July 2002. An extended range version, known as JASSM-ER, with a range of 1,100 km was proposed in 2001 using a turbofan engine and carrying more fuel.

Initial integration trials are being made on F-16 Fighting Falcon and B-52H Stratofortress aircraft but, in addition, it is planned that JASSM will be carried on B-2A Spirit, F/A-18 Hornet and Super Hornet, F-15E Strike Eagle, F-117 Nighthawk, P-3C Orion, and B-1B Lancer aircraft. The fighter aircraft will carry one or two missiles on underwing pylons, the B-52H will carry 12 missiles, the B-1B will carry 24 missiles, and the B-2A will carry 16 missiles. If Australia orders JASSM then the missile will be cleared from F-111C/G and Orion P-3C/W aircraft as well.

A front view of an AGM-758 (JASSM) cruise missile. with the tail fin erect for flight (Duncan Lennox) **NEW**/0536214

An AGM- 758 missile exhibited at Farnborough in 2000, with the tail fin folded down for carriage (Peter Humphris) 0093552

Description

AGM-158 JASSM is a low-wing stealthy missile. with a rounded rectangular-shaped body and a single vertical tail. The wings are swept back and rectangular, with wings and tail unfolded after launch by small explosive devices. The body is made from composite materials. The missile is 4.26 m long, has a body width of 0.55 m, a height of 0.45 m, an extended wing span of 2.7 m, and a launch weight of 1,023 kg. The warhead is a JAST-1000 HE penetrator, with a length of 1.82 m, a diameter of 0.295 m, a weight of 432 kg and with 103 kg of HE. This warhead has a dual-mode capability, for penetration or blast/fragmentation. Guidance in mid-course uses the same INS/GPS unit that was developed for the JSOW and JDAM guided bombs, with a high-level cruise altitude, although there is an option for a low-level cruise at 500 m altitude. The cruise phase is followed by a steep dive on to the target using an imaging I!? seeker based upon the technology of the US Army Javelin missile seeker. The terminal seeker operates at 3 to 5 microns with a 256 × 256 focal plane array, and has autonomous target recognition algorithms. There will be no datalink or man-in-the-loop during the terminal phase. However, a digital datalink is being considered to provide bomb impact assessment, with a 395 MHz link between a 25 W transmitter in the missile and either an RC-135 Rivet Joint aircraft or via a satellite to a ground station or aircraft. It is reported that later upgrades may consider alternative terminal seekers, including millimetric-wave active radar, synthetic aperture radar and laser radar options. JASSM has a turbojet engine, using a Teledyne J402-100 engine developed for the AGM-84E SLAM missile, with a maximum range believed to be around 500 km. The missile is planned to have a 15 year storage life.

AGM- 158JASSM missile 0062318

Operational status

Project definition studies were awarded in 1996, with a 40-month engineering and manufacturing development contract

awarded in November 1998 and 40 test missiles to be built. The EMD phase was extended to four years in 1999, following development problems. Initial carriage flight and jettison tests started in 1997, and the first free flight trial was in April 1999. There are plans for 10 development flights, followed by eight initial operational evaluation flights starting in 2002. The first six development flights were made in 2001, with ranges from 80 to 313 km reported, and four successful tests. The first live warhead test was made in April 2001.

By July 2002 a total of 14 release flights, 6 unpowered and 8 powered development tests had been completed. DT-9A was made in July 2002, with the first test of a Block 1A missile, which was released from a F-16 aircraft. Low-rate initial production for 95 missiles started in December 2001, and is expected to be followed by a second batch of 105 missiles in 2003, with final assembly and test at the Lockheed Martin production facility at Troy in Alabama. Full-rate production is expected to start in 2004, at a rate of 250 missiles per year. An option for 1,165 missiles is believed to have been included in the EMD proposal, but it is reported that the USAF has a total requirement for 3,700 missiles with deliveries from 2003 to 2014. An initial operational capability is expected by the end of 2003.

In 1999 it was reported that the USN would probably order 700 JASSM with deliveriesstarting in 2004, but in 2002 this figure had been reduced to 450 missiles. An export version of AGM-158 was offered to Australia in 1999, but this order has not been confirmed. South Korea may request JASSM for fitting to their F-15K aircraft.

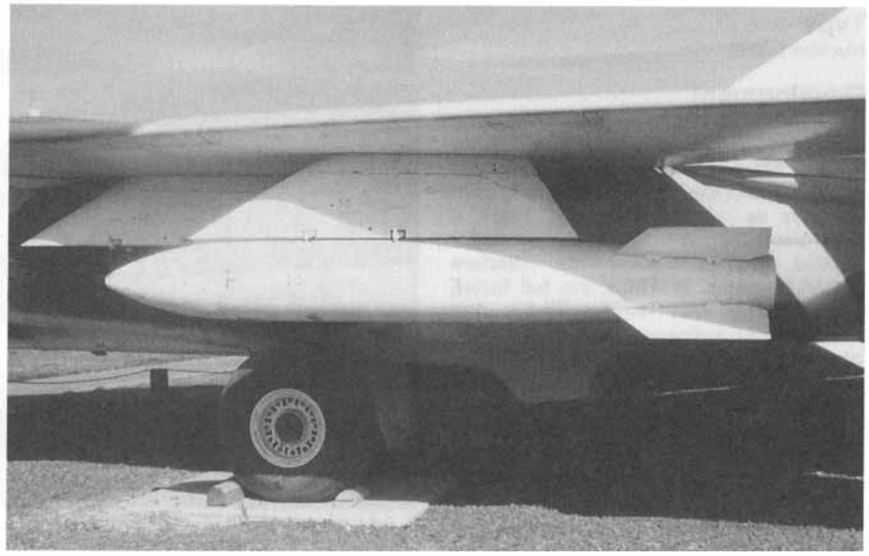
Specifications

Length: 4.26 m
Body width/height: 0.55 m/0.45 m
Launch weight: 1,023 kg
Payload: Single warhead; 432 kg
Warhead: HE penetration
Guidance: Inertial with GPS and imaging IR
Propulsion: Turbojet
Range: 500 km
Accuracy: n/k

Contractor

Lockheed Martin Missiles and Fire Control Systems, Orlando, Florida.

B57 nuclear bomb



A B57 bomb on the wing pylon of a F-111 aircraft (Peter Humphris) NEW/0536215

Type

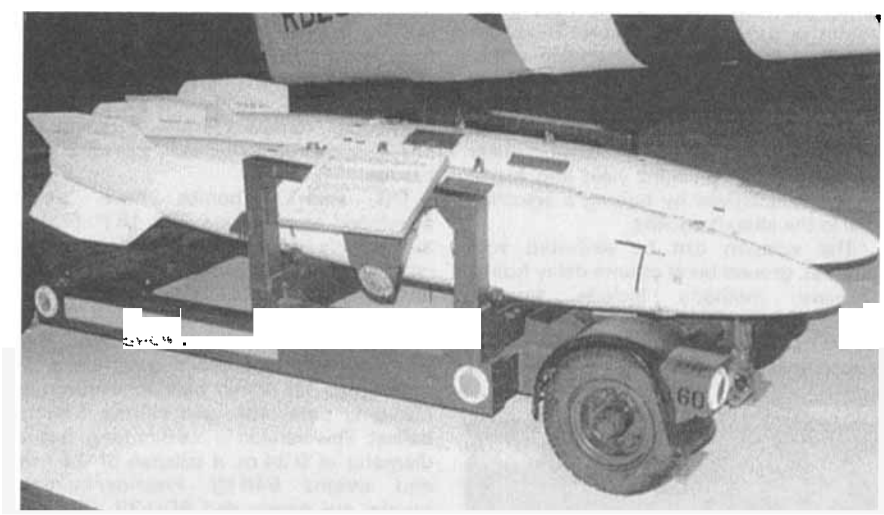
Nuclear bomb/depth charge.

Development

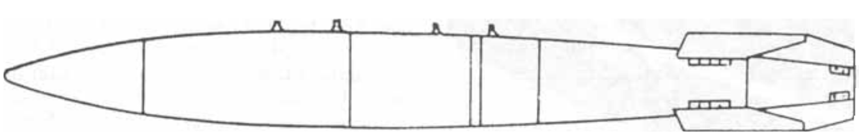
The B57 nuclear bomb was designed as a lightweight, multipurpose nuclear depth charge and nuclear bomb to be used for Anti-Submarine Warfare (ASW) and land warfare. Development started at the Los Alamos National Laboratory (LANL) in 1960. Early production started in 1963 and initial deployment was in 1964. The weapon has been cleared for carriage on the S-3 Viking, P-3 Orion, B-52 Stratofortress and Nimrod aircraft, SH-60F Seahawk, SH-3 Sea King and Lynx helicopters, and a wide variety of tactical aircraft including the F-4 Phantom, A-6 Intruder, A-7 Corsair, F-15E Strike Eagle, F-16 Fighting Falcon and F/A-18 Hornet. It is believed that the B-2A Spirit has also been cleared to carry B57 bombs.

Description

The B57 is a low-yield, low-drag, lightweight multipurpose nuclear depth charge or bomb. It has three interchangeable slightly rounded noses and four swept fins at the rear. The bomb is 3.0 m long, has a body diameter of 0.38 m and weighs about 230 kg. The nose section contains dual-channel fuzing radars, antennas and power supplies, and was developed primarily for airburst delivery but can also be used for 'laydown' or depth bomb delivery. There are two water entry flooding ports used in depth bomb delivery. The warhead materials are unknown but it is likely to be a fission weapon. The B57 has variable yield options in the 5 to 10 kT range. It has the capability for air, surface or underwater bursts. The fuzing options are thought to be selected on the ground by maintenance personnel and a depth pressure fuze is used for underwater detonations. From Mod 2 onwards the bomb was fitted with a Permissive Action Link (PAL), which permits the weapon to be armed or allows access to the warhead only with the correct code. The weapon has both 350 and 762 mm (14 and 30 in) separation suspension lugs for carriage by a variety of aircraft. Delivery modes include laydown, over the shoulder and low- or medium-angle loft. Minimum altitude for laydown delivery is 90 to 180 m. Practice bombs are designated BD-12 and BD-19.



Two B57 nuclear bombs on a loading trolley (Peter Humphris) 0062317



B57 nuclear bomb

Operational status

The B57 bomb entered service in 1964 and production ceased in May 1967 after approximately 3,100 bombs had been made. Retirement of the early versions started in June 1975, but some Mod 2s and later versions are still in service with the USA. Approximately 1,000 weapons were deployed in 1983 and it is believed that about 425 remained in service in 1993. However, in 1993, all the remaining B57 depth charges and bombs were withdrawn from NATO countries and removed from US ships. for storage in the USA. It was reported in 1994 that around 150 B57 depth charges would be retained in the reserve stockpile in the USA, and the remaining non-operational bombs would be destroyed.

Specifications

Length: 3.0 m
Body diameter: 0.38 m
Tailspan: 0.52 m
Lug spacing: 762 and 350 mm
Weight: 230 kg
Yield: 5-10 kT
Accuracy: n/k

Contractor

Not known.

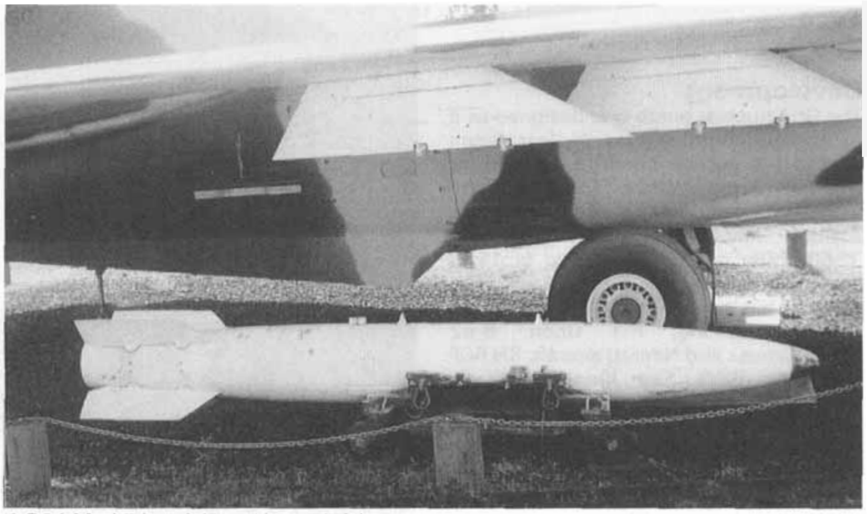
B61 nuclear bomb

Type
Nuclear bomb.

Development
In 1960, the US Air Force became interested in the possibilities of using drogue-retarded nuclear weapons, which could be dropped at high speeds from altitudes as low as 100 m. In 1961, a programme began to develop a bomb for tactical and Anti-Submarine Warfare (ASW) missions. In 1963, the full fuzing option bomb was named TX-61, and development engineering began at the Los Alamos National Laboratory (LANL). Production engineering of the B61-0 started in 1965 and the first weapon was deployed in 1967. Over the years there have been 11 different modification series. The main differences between the Mod 0s to 5 are safety features and delivery capabilities, but the Mod 3 weapon was the first US nuclear weapon to use microprocessor-based arming and firing sequence circuits.

The Mod 7 version included a new Permissive Action Link (PAL) system and a new high-yield warhead, in order to replace the Mk 28FI bomb. Sandia National Laboratory started evaluating the B61 bomb design in 1987 to develop a hard target or earth-penetrating nuclear bomb, as a replacement for the B53. In 1997, reports indicated that a B61 Mod 11 earth-penetrating nuclear bomb had been developed and tested. A life extension programme was started in 1999, and in March 2002 a proposal was made to use the B61 warhead in a stronger body, to attack deeply buried targets. The penetration version is expected to be much heavier, probably with a weight of 1,030 kg.

The B61 bomb has been cleared for carriage on the A-6 Intruder, A-7 Corsair 2, F-4 Phantom, Tornado, F-15E Strike Eagle, F-16 Fighting Falcon, F-111 Raven, F-117 Nighthawk and B-52H Stratofortress aircraft, and the B61 Mod 11 has been cleared on the F-15E Strike Eagle, F-16C Fighting Falcon, F-117 Nighthawk and B-2A Spirit aircraft.

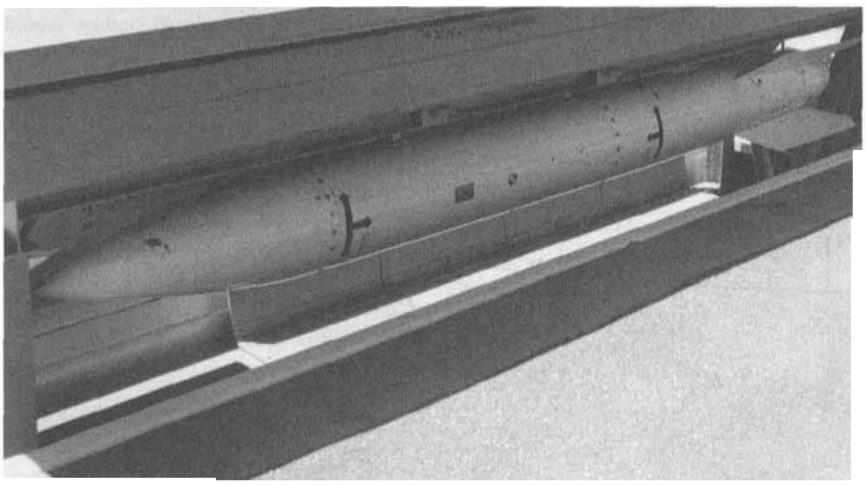


A B61 Mod 7 bomb (Peter Humphris) *NEW*/0536216

Description
The B61 is a lightweight, low-drag, variable yield, multipurpose thermonuclear tactical bomb for use on a wide range of aircraft. The bomb can be used as a strategic or as a tactical weapon. It is aerodynamically shaped, has a pointed nose and four swept fins at the rear. The bomb is 3.6 m long, has a diameter of 0.34 m and weighs between 315 and 325 kg. The warhead contains Oralloy as the fissile material and Lithium-6 Deuteride and Tritium for fusion and with either HE PBX 9404 or IHE PBX 9502 explosive surrounding the core. The bomb has four separate and selectable yields, three strategic yields between 100 and 500 kT, and a tactical low-yield (10 kT) option. The yield was selected and set before take-off in early bombs; later variants feature in-flight yield and fuzing selection achieved by turning a selection dial in the aircraft cockpit.

The weapon can be delivered with airburst, ground burst or time delay fuzing. Delivery methods include free-fall, parachute retarded or laydown from as low as 15 m, and the bomb can be delivered at supersonic speed. The B61-0 and B61-2 have Cat B PAL, which permits the weapon to be enabled or access to the warhead itself with the correct code. Some B61-1 bombs were converted to B61-7s as a strategic version for carriage on the B-52 and F-111 aircraft. The B61-3 and -4 are basically the same as Mod 0 and 1 but have an upgraded Cat F PAL and disable via a weak/strong link, which is driven by a signal generator. The B61-5 has a Cat D PAL, non-violent command disable and weak/strong link switch driven by a signal generator. B61-3, -4 and -5 were used for NATO delivery systems. The B61-7 weapons are designed for low-level high-speed delivery against hard targets. It is reported that some W85 nuclear warheads, removed from Pershing 2 missiles, were converted into B61-10 bombs.

The B61-11 bombs have been developed to penetrate 2 to 15 m below the earth's surface before detonating, creating a strong ground shockwave to destroy underground facilities. The Mod 11 bomb is described as a repackaged Mod 7 weapon, with a steel case around the warhead and electronics assemblies, a redesigned tail flared section, without a retarding parachute, and carries 114 kg ballast. This version is 3.68 m long, has a diameter of 0.34 m, a tailspan of 0 57 m and weighs 548 kg. Practice/training bombs are designated BDU-36, BDU-38 and BDU-39E.



An early B61 nuclear bomb 0062315

Operational status
The B61 bomb entered service in 1967 and. by 1987, approximately 3,150 (including 1,000 Mod 0, 1 and 7 bombs and 2.100 Mod 2, 3, 4 and 5 variants) had been produced and deployed The Mod 6 and 8 were also deployed The B61 was in service with the USAF, USN and the US Marine Corps and other NATO air forces, but most have now been withdrawn from service In 1994, it was estimated that 400 B61 nuclear bombs would be retained in Europe for tactical air force use in Belgium, Germany, Greece, Italy, Netherlands and the UK.

In 2001 it was reported that 150 bombs remained in Europe Around 1,300 bombs were reported operational in June 2002, with the majority stored at Nellis AFB, Nevada and Kirtland AFB, New Mexico Some additional bombs may be held as spares in the inactive stockpile in the USA. B61 Mod 11 conversion kits were made starting in 1996, and some 50 B61 Mod 7 bombs had been converted by the end of 1997. The Mod 11 became operational in 1997. In 2000 it was reported that the USAF will only use F-15E, F-16, F-117 and B-2A aircraft to deliver B61 bombs, although some B-1B bombers could be re-roled in an emergency.

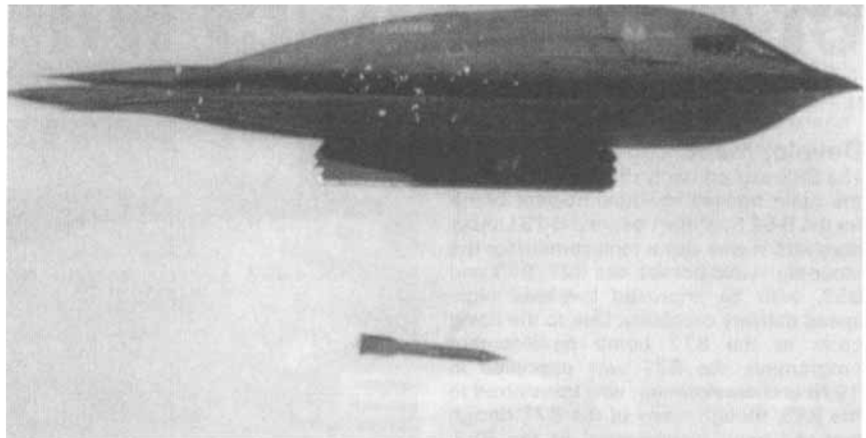
Specifications

B61 Mod 7
Length: 3.6 m
Body diameter: 0.34 m
Tailspan: 0.58 m
Lug spacing: 356 and 762 mm
Weight: 315-325 kg
Yield: 10 kT or 100-500 kT
Accuracy: n/k

B61 Mod 11
Length: 3.68 m
Body diameter: 0.34 m
Tailspan: 0.65 m
Lug spacing: 356 and 762 mm
Weight: 548 kg
Yield: 100 to 500 kT
Accuracy: n/k

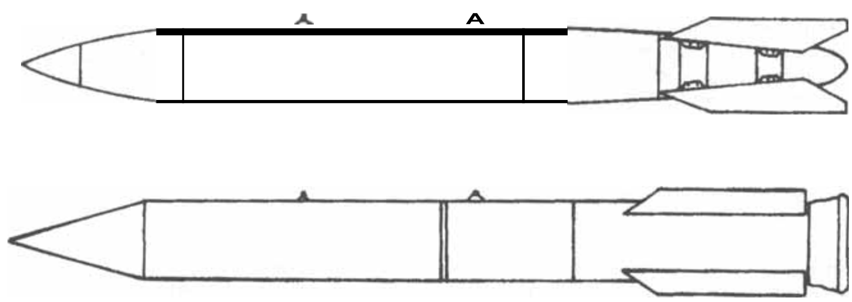
Contractor

Not known.



*A **B-2 Spirit bomber releasing a B61-11 earth penetrating nuclear bomb during tests in** 1997* (USAF)

0038278



B61 nuclear bombs, Mod 7 (upper) and B61 Mod 11 (lower)

0062316

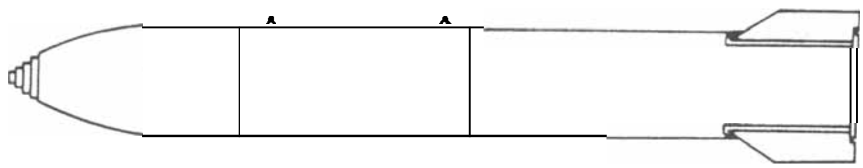
B83 nuclear bomb

Type
Nuclear bomb.

Development
The B83 was primarily designed for use as the main free-fall strategic nuclear bomb for the B-52 Stratofortress and B-1B Lancer bombers. It was also a replacement for the older high-yield bombs, the B28, B43 and B53, with an improved low-level high-speed delivery capability. Due to the rising costs in the B77 bomb development programme, the B77 was cancelled in 1978 and development was transferred to the B83, though many of the B77 design features were incorporated in the B83. Development of the B83 started at the Lawrence Livermore National Laboratory (LLNL) in the late 1970s and production engineering started in September 1980.

The first production units were completed by June 1983 and quantity production started three months later. Initial deployment was in 1984. The B83 was the first megaton-class bomb to be specifically designed for 'laydown' against hard, irregular targets. Its nosecone is especially configured to reduce shock during 'laydown' delivery on targets such as steel-reinforced concrete runways, missile silos, or industrial steel girders. The nosecone was extensively redesigned when changes in weapon design led to changes in expected impact velocities. Although initially designed for carriage by the B-52H Stratofortress and B-1B Lancer, the B83 was also cleared for carriage on the B-2A Spirit, and FB-111 strategic bombers, and on the F-4 Phantom, F-111 Raven, A-6 Intruder, A-7 Corsair, F-15E Strike Eagle and F-16 Fighting Falcon aircraft.

B83 bomb being released from a trials B-1B Lancer bomber NEW/0006404



B83 nuclear bomb

Description
The B83 is a strategic (high-yield), low-drag weapon with a low-level laydown capability. The bomb is 3.66 m long, has a body diameter of 0.46 m and weighs 1,088 kg. The W83 warhead is believed to contain a Plutonium/Oralloy mix with Improved High Explosive (IHE) PBX-9502, and to have a yield in the low megaton range believed to be 1 to 2 MT. The B83 uses a special stainless steel shock mitigation nosecone, a series of concentric frangible rings, in lieu of the aluminium honeycomb noses on earlier 'laydown' bombs. In addition, the warhead of the bomb is mounted forward to minirnise displacement on impact. A series of ring-like exterior teeth inhibit sliding of the weapon along a surface and prevent translation of kinetic energy into rotational energy (which happens when a bomb glances off a hard surface).

The weapon is capable of a laydown delivery from as low as 45 m at speeds in excess of M1.0, and has been designed to survive impact velocities in excess of 30 m/s, with detonation delayed by up to 120 seconds to allow the delivery aircraft to get clear of the target area. It has flexible fuzing options including a groundburst capability. Also incorporated is a new parachute system, which consists of a 13.72 m diameter single-stage parachute deployed by three small 1.22 m diameter pilot chutes. The main chute is capable of slowing the bomb down from M2.0. The bomb is fitted with Cat D PAL (Permissive Action Link) which permits the weapon to be enabled or for access to the warhead itself with the correct code. Other safeguards and arming features are non-violent command disable and a weak/strong link switch driven by a signal generator. The weapon is suitable for destroying hardened ICBM silos and launch complexes, command and control facilities as well as hardened nuclear weapon storage sites.

B83 bomb (rear) with set of components in the foreground (US DOE) NEW/0051965

Operational status
The B83 is believed to have started production in 1983 and to have entered service in 1984. In 1987, approximately 1,000 B83s were in the US nuclear stockpile; another 1,500 were planned but it is believed that the programme was terminated in 1991, with a total of approximately 1,400 bombs in service.

In 1994, reports indicated that 500 B83 would be retained in store for operational use, some would be held in the inactive stockpile as spares, and the remainder

would be destroyed. It is believed that in January 2002 the number retained for operational use was reduced to 200 bombs. A sample number of stored B83 bombs will be dismantled and examined by two independent inspection teams each year, as part of the US Department of Energy nuclear safety programme. In 2000 it was reported that the USAF would only use B-52H and B-2A bombers to carry the B83 nuclear bombs, although some B-1B could be re-roled in an emergency.

Specifications

Length: 3.66 m
Body diameter: 0.46 m
Tailspan: 0.9 m
Lug spacing: 762 mm
Weight: 1,088 kg
Yield: 1-2 MT
Accuracy: n/k

Contractor

Not known.

DEFENSIVE WEAPONS

An FT-2000 transporter-erector-launcher vehicle (CPMIEC) 0044948

UNCLASSIFIED PROJECTS

Introduction

There are a number of defensive weapon systems, some probably not continued with, some in development and some in service, for which we have insufficient information to create a full entry. These are listed below in country order.

ARGENTINA

Halcon

It is reported that CITEFA have developed a short-range Surface-to-Air Missile (SAM) called Halcon for the Argentine armed forces. Halcon is similar to the Roland missile and can be fired from existing Roland launch vehicles. Argentina bought four shelter mounted Roland 1 fire units in 1979. The Halcon missile has CLOS guidance using radar or EO sensors, a maximum range of 7 km and a maximum altitude of 6,000 m (19,680 ft). Halcon weighs 90 kg and is reported to have a 12 kg warhead.

BRAZIL

FOG-MPM

A development programme was started in the mid-1980s for a ground-launched TV fibre optic guided anti-tank and anti-helicopterr missile, with the designator MAC-MP. The project is lead by Avibras, and the name was changed to the Fibre Optic Guided Multi-Purpose Missile (FOG-MPM). In 1995 a ship-based system was proposed, and in 1999 it was reported that the missile would be fitted in vertical launch canisters on upgraded Inhauma and Barroso class corvettes for air defence against helicopters and slower moving aircraft targets. FOG-MPM is 1.8 m long, has a body diameter of 0.18 m, and a launch weight of around 40 kg. The original missile had a range of 10 km, but more recent reports suggest 20 km. The missile has four rear folding rectangular fins at the nose, four rear folding rectangular wings at the rear, and a solid propellant motor with two exhaust nozzles in the side of the rear body section. The TV seeker is mounted at the nose, and the fibre optic cable reel at the rear of the missile. An initial batch of around 30 missiles was built for development flight testing and ground trials, and evaluation is planned to continue until 2004, with a possible in-service date of 2006.

CHINA, PEOPLE'S REPUBLIC

Laser weapons

AZM-87 Portable Laser Disturber, made by NORINCO, was exhibited in 1995. This laser weapon had been designed to damage electro-optical sensors and dazzle the human eye at ranges up to 3 km. The equipment was portable and weighed about 35 kg.

A report in December 1998 indicated that China has developed a ground-based laser weapon capable of damaging the electro-optical sensors of a satellite in low earth orbit. This system is believed to use a deuterium fluoride chemical laser and became operational in mid-1998. The site is located in central China. A further development programme is working on a more powerful system to damage satellite structures.

HQ-9

Reports in June 1996 indicated that China was developing an improved Russian SA-IO 'Grumble' (S-300 Buk) air defence system, possibly using some imported US MIM-104 Patriot guidance technology. The Chinese designator for this system was HQ-9, which may have been based upon the HQ-10 surface-to-air missile system, believed to be a licence-built SA-IOC (S-300PMU). Alternatively, it is possible that HQ-9 was an attempt to reverse engineer the MIM-104 Patriot system, although it is not clear how the technology was transferred to China. An unconfirmed report suggests that the Chinese export designator for HQ-9 is FD-2000. This might imply that the missile is similar to that used in the HQ-15 anti-radar surface-to-air missile system, which has the export designator FT-2000.

A Brazilian FOG-MPM missile displayedin Paris in 1999 (Duncan Lennox) *NEW*/0132642

HQ-10

It is reported that China has imported Russian SA-1OC 'Grumble' (S-300PMU) surface-to-air missile systems and is now building these under licence in China with the Chinese designator HQ-10. The Chinese are believed to have ordered 70 missiles in 1991, and a further 120 missiles in 1994. These missiles have been deployed around Beijing. Licence build of the missiles in China probably started with final assembly and testing in 1997, and a flight test of the new missile was reported in 1998. A flight test was also reported in 1999 against a short-range ballistic missile target, but it is not known if this test used a Russian- or Chinese-built missile. The 5P85S wheeled TEL vehicle from the SA-IO 'Grumble' has been used in the new Chinese HQ-15 (export designator FT-2000) anti-radar surface-to-air missile system.

HQ-16

The HQ-16 project is reported to be a joint Russian/Chinese development of the Russian SA-I 1 'Gadfly' and SA-I 7 'Grizzly' surface-to-air missile systems, for use from mobile ground vehicles and later from ships. This system is believed to have the Chinese export designator MD-2000. The improved HQ-16 missiles will have a maximum range of 65 km. The Chinese have already used a modified SA-I I/-17 missile with their HQ-15 anti-radar surface-to-air missile system, which has the export designator FT-2000. It is possible that the improved HQ-16 missiles will be used on the Chinese 'Sovremenny' class destroyers purchased from Russia, as later upgrades to the existing SA-N-7 'Gadfly' missiles.

HQ-17

The HQ-17 programme was reported in March 2000, following an agreement between Russia and China for the Chinese to manufacture Russian SA-I5 'Gauntlet' (Tor-MI) surface-to-air missile systems under licence. The Chinese plan to build 160 TELAR vehicles and around 3,000 missiles. with an in-service date of 2005. It is expected that the Chinese may also develop a ship-launched version of this missile, based upon the Russian naval SA-N-9 'Gauntlet' system.

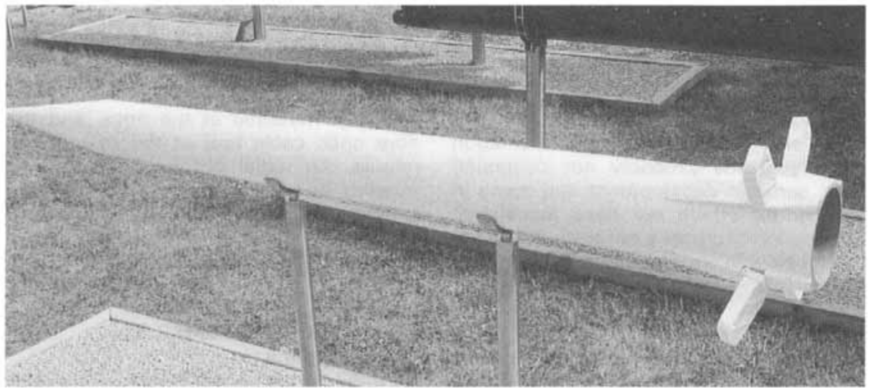
ASAT

The Chinese are believed to have started an anti-satellite (ASAT) programme in 1989. A report in May 2001 indicated that a flight test was being prepared. A ground-based silo-launched missile, with solid propellant motors, using a co-orbital approach is expected. Possible warhead methods might be HE fragmentation, ECM/IRCM, or to attach the warhead to the satellite to disable the electronics.

FRANCE

Latex

A ground-based laser defence weapon research programme, known as *Laser*


A LFK version of the HFK/L missile. displayed in 1998 (Paul Jackson) 0044942

Associe **a** *une Tourelle EXpérimentale* (LATEX), started in 1985. This programme has researched laser applications for air defence with DGA, Aerospatiale (now part of MBDA) and Thomson-CSF (now Thales) participation. Test firings of several laser designs have been made against various aircraft and missile targets since 1989, and reports suggest that free electron laser prototypes are being developed with powers up to 1 MW. A joint military laser research programme was started in 1998 with French and German government and industry participation, at the Centre de Laser Franco-Allemagne (CLFA) located at Arcueil in France. A five year research programme was planned. 'A megajoule laser is also being prepared by the French *Commisariat a l'Energie Atomique* (CEA)to produce up to 1.8 MJ of energy with 240 laser beams focussed onto a target.

GERMANY

Ground-based laser

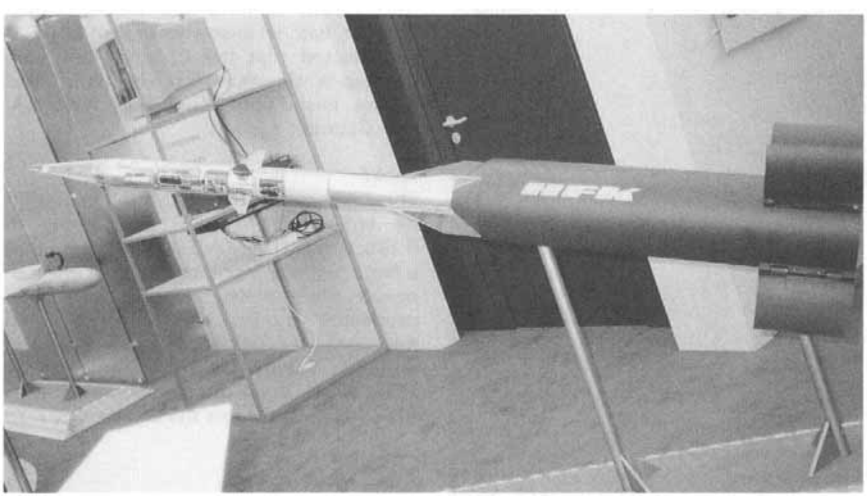
A research study for a high-energy laser air defence weapon was awarded to DASA (now LFK, part of EADS) in 1988. A carbon dioxide laser system was proposed, mounted on a converted Leopard tank chassis. Trial firings have been made against aircraft and missile targets. A joint military laser research programme was started in 1998 with French and German government and industry participation, at the Centre de Laser Franco-Allemagne (CLFA) located at Arcueil in France. A five year research programme was planned.

HFK

A Hochgeschwindigkeitsflugkorper (HFK) hypervelocity surface-to-air missile research programme was started in Germany in 1990, and at least two different designs have been tested. A BGT design, known as HFK/KV, was tested with eight firings up to December 2001. The missile had a length of 2.8 m, and a launch weight of 60 kg. This missile was in two stages, with the 44 kg first stage a solid propellant boost motor fitted with four folding fins that accelerated the missile up to M 5 in around 1 second. The boost motor assembly was then jettisoned and the unpowered second stage flew to the target. The 16 kg second stage was called a Kill Vehicle (KV), this had a length of 0.9 m, and had an inertial measurement unit, a 5 kg warhead, four small control fins and an imaging IR seeker. The seeker had 32 detector elements that were scanned to provide an image, enabling the second stage to home onto the target. The imaging IR seeker was protected from the heat generated by the high speed of the missile, by an ablative nosecone, that was jettisoned 2 to 3 seconds before intercept. The HFK/KV missile design was planned to be interchangeable with existing Roland canisters and launch systems, and was expected to have a maximum range of 12 km.

A second version was designed by DASA (LFK, now part of EADS), known as HFK/L. This version was a single-stage missile, but with a solid propellant boost motor that burned for 0.8 seconds and accelerated the missile to M5.3 (1.8 km/s). The HFK/L missile was first flown in 1995, and guided flight trials continued up to February 2002. The missile had a launch weight of 100 kg and included 36 solid propellant side thrusters forward of the centre of gravity and four lattice box type control fins at the rear. The lattice control fins were similar to those used on the Russian AA-12 'Adder' air-to-air missile and SS-21 'Scarab' short-range ballistic missile. It was reported that this missile would have active or semi-active radar guidance, although a dual-mode active radar/imaging IR seeker was also proposed. The initial HFK/L missile had a range of 12 km. In October 2000 a second phase of research was contracted with LFK, to develop two further missiles with a larger boost motor. The new motor will burn for 1.8 seconds, and will accelerate the missile to M7.0 (2.3 km/s). The first test of the new missile was made in February 2002.

A joint proposal was made by BGT and LFK in June 2001 to co-ordinate the two earlier projects into one design, to be used as a replacement for the Roland SAM and for possible use as an AAM from helicopters. The new design is for a two-stage missile, with first- and second-stage solid propellant motors. The first-stage motor has TVC. The motor efflux from the second-stage motor will be exhausted from two side nozzles in the missile body, forward of the wings. This will enable the two motors to be fired together or sequentially, depending on the target range. The missile has four long chord wings at mid-body and four control fins at the rear, similar to the IRIS-T air-to-air missile and SM-2MR Standard surface-to-air missile. The flight speed will be 2.0 to 2.5 km/second, with a range in excess of 10 km. The second stage has an IIR seeker, with inertial guidance in mid-course and a command uplink to enable the missile to intercept targets behind hills or terrain cover. A small fragmentation warhead will probably be fitted, although the objective is to achieve 'hit-to-kill'. Full-scale development is expected to start in 2004, with a planned in-service date of 2009.



A sectioned model of the BGT version HFK/KV two stage missile (Peter Humphris) 0044941

TLVS

DASA (LFK, now part of EADS) and IABG studied the design of a possible HAWK/Patriot replacement system, known as the Taktisches Luftverteidigungssystem (TLVS). A concept study started in 1989; this examined a vertically-launched SAM with a range around 30 km and an active radar terminal seeker. It is considered unlikely that Germany would fund a national SAM programme and more likely that the TLVS programme will be used to contribute to future collaborative projects, similar to the active radar seeker development for MIM-104 Patriot. The TLVS definition phase began in 1993 and included studies on the French/Italian FSAF (Aster SAM) programme as well as the US Corps SAM proposals. Germany joined the International MEADS programme in 1995 and it is believed that this will encompass future TLVS studies. Although the TLVS project was completed in 1995, continuing doubt about the MEADS programme has meant that another option has been kept open in case

the German participation in MEADS were to cease.

INDIA

Trishul

Trishul was the short-range surface-to-air missile system in the DRDO long-term Guided Missile Development Programme started in 1983. This SAM was required for Army, Air Force and Navy use, and its development was based upon the Russian 1960s design for the SA-8 (SA-N-4) 'Gecko' (9M33 Osa) system. The Trishul missile has four moving control fins at the nose, and four fixed wings at the rear. The missile is 3.2 m long, has a body diameter of 0.21 m, and a launch weight of 125 kg. The warhead is a 20 kg HE fragmentation type, with an IR proximity fuze. Command guidance can be controlled through a radar or IRST, with two beacon transponders on the rear body of the missile. It is reported that India is using a K-band (35 GHz) engagement radar, probably the TMX-K as used with Skyguard. There is a dual-thrust boost/sustain HTPB solid propellant motor, which gives the missile a peak velocity of 750 m/second. The maximum range is reported to be between 10 and 15 km, with intercepts between 5 m and 5 km altitude. The first flight test was made in February 1986, but the programme has had many delays and there have been over 50 test firings up to the end of 2001. The first test from a ship was made in June 1997, and it is expected that Trishul will be fitted to modified Godavari class frigates replacing Russian-supplied SA-N-4 missiles. The Army are expected to fit three missile canisters onto a modified BMP-2 chassis, called the Trishul Combat Vehicle (TCV) and built under licence in India by the Medek Ordnance Factory. The Air Force are expected to have a four missile launch vehicle, using a modified Tatra Kolos truck, built under licence in India by BEML. The Trishul SAM system is expected to enter service in 2003/2004.

INTERNATIONAL

HVG

A joint French/German research programme into the use of Hypervelocity guns (HVG) for surface-to-air and surface-to-surface uses was announced in 1993. The work was co-ordinated by the Franco-German Institut Saint Louis (ISL). A 120 mm coil gun and a 105 mm electro-thermal gun were installed with 30 MJ capacitor banks for pulsed power supplies. In addition, a 50 mm rail gun powered by a 10 MJ pulse was also provided.

Medium Extended Air Defense System (MEADS)

An international MoU and NATO Agency charter was negotiated following an initial agreement between France, Germany, Italy and USA in February 1995 to collaborate in the joint MEADS Surface-to-Air Missile (SAM) programme. In May 1996, France withdrew from the programme and the remaining three nations signed an MoU for the project definition and validation phase. The objective was to develop a mobile SAM system capable of defending ground forces against tactical ballistic missiles, cruise missiles and manned aircraft threats with an initial in-service date of 2005. This programme was shared 60 per cent by the USA, 25 per cent by Germany and 15 per cent by Italy, but the cost sharing has been revised and is now 55 per cent for the USA, 28 per cent for Germany and 17 per cent for Italy. MEADS used earlier US Corps SAM work, and MEADS is being run by a NATO Agency, NAMEADSMA, based in Huntsville, USA.

In early studies an integral part of the MEADS system was to have been an airborne radar sensor, to provide early warning against low-flying cruise missiles and aircraft targets, and this could be mounted on an aircraft, helicopter, UAV or aerostat. However, it is believed that this has now been shelved because of the additional cost, and that the initial system will have separate vehicle-mounted surveillance and engagement radars.

The MEADS system will probably be fully interconnected by datalinks with other air defence systems such as MIM-104 Patriot, THAAD and FSAF Aster. MEADS will have to be both mobile and air-transportable by C-130 Hercules and C-160 Transall size aircraft, and probably also by heavy lift helicopters such as the CH-47 and CH-53, and will in effect be an MIM-23 HAWK and MIM-104 Patriot replacement. Present proposals are to use the PAC-3 missile, possibly modified to improve its performance. There are expected to be two versions of the missile; a hit-to-kill missile for intercepting ballistic missiles and a fragmentation warhead missile for use against aircraft and air-breathing missiles.

The PAC-3 missile is expected to have a range of 20 km, and to intercept targets between 50 m and 15 km altitude. Proposals in 2001 were that the ground-based radars associated with MEADS will have 360° coverage. The surveillance radar will be UHF, and the dual-role surveillance/engagement radar will be X-band, together with an X-band uplink/downlink between this radar and the missile. Both radars will have active phased arrays with pulse-Doppler and adaptive digital beam forming. The missiles will be vertically launched from a mobile launch vehicle. Lockheed Martin are developing a lightweight launcher for eight PAC-3 missiles, using a 5T medium tactical vehicle chassis, which with a weight of 16,000 kg would be C-130 transportable, and this might be adopted for MEADS.

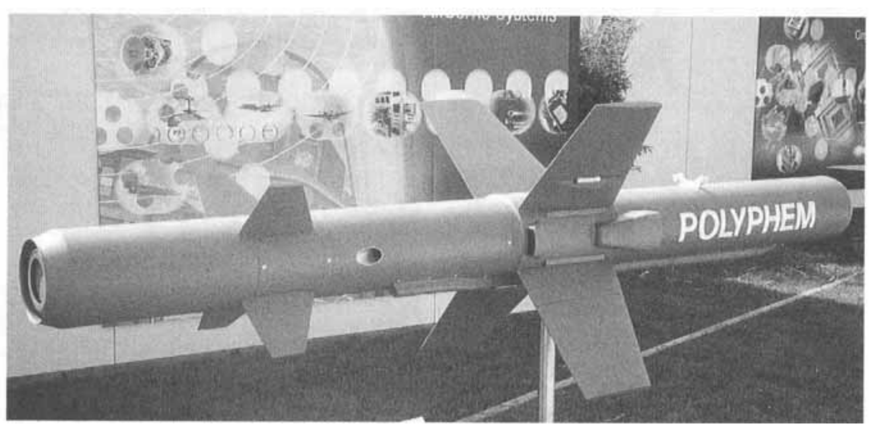
A typical battery is planned to have six launchers, each with 12 missiles, three re-load vehicles, each with 12 missiles, two tactical operations centres and two support vehicles, one UHF surveillance radar, and two dual-role surveillance/engagement radars. The manpower for a battery would be around 50 personnel, and a complete battery would take 20 C-130 loads or 38 C-160 loads. A project definition and validation phase was completed in 1998, and in June 1999, a team led by Lockheed Martin Missiles and Fire Control was selected for the next phase, which will be a three-year risk reduction effort. The Lockheed Martin team includes LFK (part of EADS) from Germany and Alenia Marconi Systems from Italy. A risk reduction programme started in July 2001 and will complete in 2004. Prototype system tests are now planned for 2004, with engineering and manufacturing development starting in 2005 and completing in 2011. A revised in-service date of 2010 to 2012 has been discussed, but not yet formally agreed.

Modified Air Defense System (MADS)

The MADS programme was a joint USA and Taiwan development for the provision by Raytheon of some technologies for a surface-to-air missile system based on the MIM-104 Patriot system. This was a separate programme from the Tien Kung 1/2 (Sky Bow 1/2) missile system, which is described in a separate entry. Deliveries associated with the MADS programme were expected to begin in late 1996 with the MADS replacing one MIM-14 Nike Hercules battery, but following the agreed sale of MIM-104 Patriot PAC-2 missiles to Taiwan, the status of the MADS programme remains unclear. It has been reported that MADS was similar to Patriot PAC-2, but with licensed manufacture of some components in Taiwan.

Polyphem/TRIFOM/Triton

A joint French-German-Italian Polyphem design and development programme, started in 1982, to investigate the use of fibre-optic cable as a command system for use with guided missiles. Several designs have been tested over the years, and it would appear that Polyphem is the name of the overall programme. The present missile variants are known as the Trilateral Fibre-Optic Guided Missile (TRIFOM) for the longer range ship, vehicle or helicopter launched missile, and as Triton for the shorter range submarine-launched variant. Fibre-optic cable is used to relay pictures

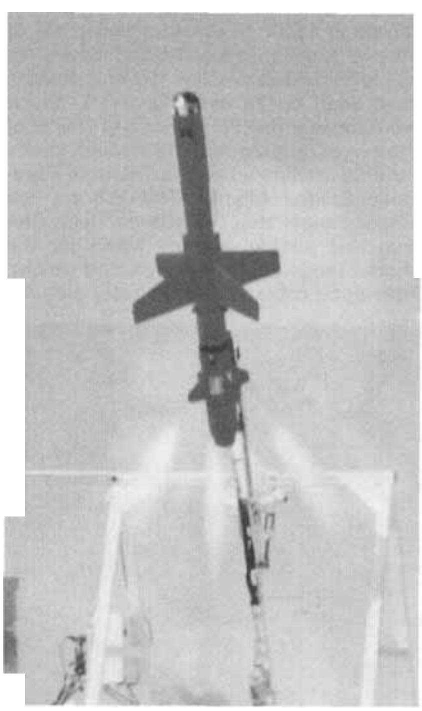


A model TRIFOM missile, exhibited at Pans in 7999 (Peter Humphris) 0062337

from a TV camera or IIR seeker in the nose of the missile to a ground operator station, with command guidance sent back up the cable from the operator to the missile. While initial programmes are concentrating on UAV reconnaissance and surface-to-surface offensive weapons to attack mobile or fixed land targets, there has always been the intention to develop a surface-to-air variant. Polyphem trials have indicated that ranges up to 60 km are possible, but it is believed that any SAM would be restricted to a 20 km range. Flight tests started in 1995 as part of a three-year demonstration programme on the surface-to-surface version, with the first guided firing in April 1997.

A 33-month operational evaluation phase was started in July 1998 for the TRIFOM variant, following a contract award from the German BWB to a team comprising LFK (part of EADS), Aerospatiale Matra Missiles and Italmissil (now MBDA Missile Systems). The TRIFOM missile design has a length of 2.73 m, a body diameter of 0.22 m and a launch weight of 140 kg. This missile has a 20 kg HE warhead and an imaging IR seeker. The seeker operates in the 3 to 5 µm band with a FOV of 10 X 7.5" and an azimuth scan of ±30°. There is a solid propellant boost motor developed by Bayern-Chemie, with a burn time of 3 seconds and with four side exit nozzles. A turbojet sustainer motor is used, which provides a cruise speed of between 120 and 180 m/s. TRIFOM will have a maximum range of 60 km and an accuracy stated to be around 1 m CEP. An in service date of 2003 is planned for this variant.

The Triton missile programme started in 1998 as an experimental study funded by the German MoD, with LFK responsible for the missile, the submarine builder HDW for the launch containers and submarine integration, and Kongsberg Defence and Aerospace (Norway) for the fire-control system. Triton will be a submarine-launched fibre-optic cable controlled missile, for use against land targets and also as a surface-to-air missile against helicopters or slow flying aircraft such as maritime patrol aircraft. The Triton missile has 60 per cent commonality with TRIFOM, but using a solid propellant sustainer motor in place of the turbojet to give a faster fly-out speed. A private funded development programme started in 1999 in response to a potential export order, believed to be for Israel, and a demonstration launch at a land test site has been made from a depth of 60 m. It is proposed that the Triton missiles are stored in containers with four to six missiles, that can be loaded into standard 533 mm torpedo tubes. The missiles would then be fired out of the tubes without any canister, propelled by the boost motor to the surface and into the air. The Triton will have a length of 2.0 m, a body diameter of 0.22 m, and a launch weight of 120 kg. The missile will use the TRIFOM 20 kg warhead, although it is reported that a multipurpose shaped charge and blast/fragmentation warhead may be developed. The solid propellant sustainer motor will give this missile a cruise speed of 200 m/s, around M 0.6, and a maximum range of 15 km. When used against land targets, the missile will cruise at between 20 and 600 m altitude. It is expected that the TRIFOM missile imaging IR seeker will be used in Triton, giving for example the ability to acquire a helicopter sized target about 20 seconds before impact, and to make a positive identification 10 seconds before impact. This would allow the missile controller in the submarine time to evade a friendly helicopter. Triton is expected to be fitted to German built type 206, 209 and 212 submarines, and possibly to Israeli Dolphin class submarines, with a reported in service date of 2005.



A trials launch of a TRIFOM missile in April 1997 (DASA) 0062336

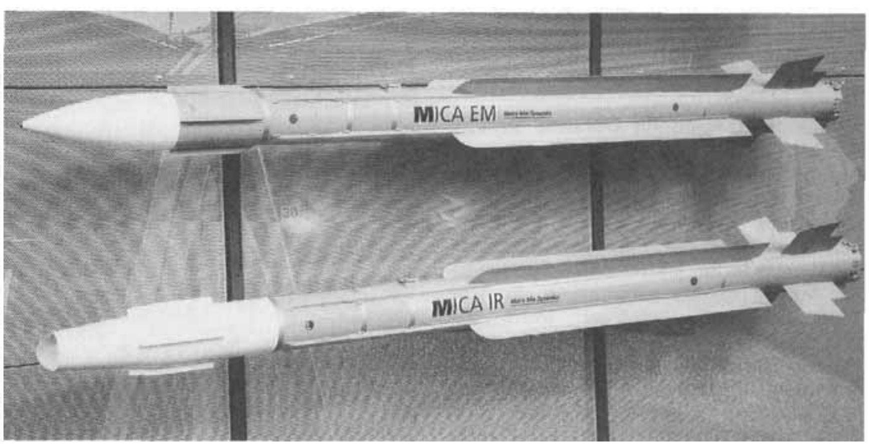
VL-MICA

A proposal for a new naval or land-based vertically-launched surface-to-air missile system was made by Matra BAe Dynamics (now MBDA Missile Systems) in February 2000. The system would use the MICA missile, which has been developed for use as an air-to-air missile, with interchangeable active radar or imaging IR seeker head assemblies. Both ship- and land-based systems would use a vertical launch canister, which has been developed from the VL Seawolf canister, in clusters of 8 or 16 canisters.

A sectioned canister containing a VL-MICA missile. displayed at Farnborough in July 2000 (Peter Humphris) 0110056

The land-based missiles would be mounted on a 5 ton truck chassis, or fitted into underground silos. The missile is 3.1 m long, has a body diameter of 0.16 m, a 12 kg HE warhead, and a launch weight of 112 kg.

The present AAM version already has a TVC assembly fitted to the reduced smoke HTPB solid propellant motor. Four missiles



The two MICA air-to-air missile versions. upper with active radar and lower with imaging IR seekers (Duncan Lennox) *NEW*/0062618

will be capable of being fired in six seconds. A missile in its specially designed VLS canister will weigh 400 kg. The first vertical launch from the new canister was made in December 2001. VL-MICA is expected to have a minimum range of 1.2 km and a maximum range of 10 to 15 km, with intercept altitudes between 2 m and 10 km. The AAM version was first tested in 1991, and entered service in 1998. Exports of the AAM version have been made to Greece, Qatar, Taiwan and United Arab Emirates, and it is assumed that these countries will be approached to consider the VL-MICA option as well. An unconfirmed report in 2001 stated that the first export order for VL-MICA had been placed by a Middle Eastern country, and that the missiles would be fitted to a ship in 2004.

IRAN

Sudace-to-Air Missiles

There have been reports from 1998 that Iran has adapted several existing surface-to-air missiles to improve their performance, and to extend their in service lives.

Project Ya-zahra is reported to be the reverse engineering of the French R 440 Crotale SAM system, following the capture of several fire units during the war with Iraq between 1980 and 1988. However, as China is believed to have exported some FM-80 fire units to Iran, it is possible that the technology was transferred as well. The Iranian Crotale variant can be used with the Skyguard fire-control system. The missiles have a length of 2.93 m, a weight of 85.1 kg and are command guided using radar, TV and IR sensors. The maximum range is 11 km against slow moving targets, at altitudes up to 5,500 m.

An Iranian built version of the Russian SA-2 'Guideline' or Chinese HQ-2 SAM is known as the Sayyed-1 missile system. with improved electronics and updated performance. Successful test launches were reported in November 1998, April 1999 and November 1999. Sawed-I is believed to have a maximum range of 60 km. This missile is believed to have been built by the Iranian Aerospace Industries Organisation.

Rapier missiles, exported from the UK in the 1970s, have been upgraded with the launcher and engagement radars mounted on the back of wheeled military trucks.

In February 1999, it was reported that Iran had successfully tested a 250 km range SAM, and this is believed to refer to an upgraded version of the Russian SA-5 'Gammon' missile system.

A report in February 2000, stated that Iran had upgraded some SM-1 RIM-66 Standard SAM with digital electronics, a frequency agile semi-active radar seeker, new warhead, motor and batteries. This upgraded version was first tested in February 2000 from a single round launcher, similar to the US designed Mk 13 launcher, fitted to a Kaman class FAC-M (Combattante 2).

ISRAEL

Israeli Boost Intercept System (IBIS)

In 1993, Israel put forward a proposal to modify either Python 3 or Python 4 air-to-air missiles, enabling them to have a longer range to intercept tactical ballistic missiles in their boost or ascent phases. The modified missiles would have boost motor assemblies added and could be launched from aircraft or UAVs. This programme was called the Israeli Boost Intercept System (IBIS), and the missile was called the Missile Optimised Anti-Ballistic (MOAB). Reports in 1996 indicated a linkage between the IBIS programme and the US Boost Phase Intercept studies conducted by BMDO. The UAV design was completed by IAI and was believed to have the designator HA-10. The UAV would have cruised at between 7 and 15 km altitude, and would carry an IRST. laser range-finder, datalinks and two to four missiles. HA-10 was designed with low IR and radar signatures, and was planned to loiter for up to 24 hours on station with a payload of 1,000 kg. Rafael have described MOAB as a missile modified from the Python 4, by adding a boost motor assembly, giving the missile a velocity of 1.5 to 2.0 km/s and a range of 80 to 100 km. The missile would use a modified terminal IR seeker, with a laser range-finder sharing the optical path for fuze initiation. It is believed that the missile would have a length of 4.0 m, a body diameter of 0.16 m and a launch weight of 150 kg. Discussions were held in late 1998 between the US and Israel to discuss a continuing joint development programme for IBIS, with an in service date between 2002 and 2005. However, in November 1999, Israel halted the IBIS development programme, preferring to develop a UAV-launched missile to attack missile launch vehicles, which has been called the Pre-Launch Intercept programme (PLI).

Derby

A classified medium-range active radar guided air-to-air missile programme was started in Israel around 1989, with Rafael as lead contractors and IAI providing the active radar seeker. The Derby project developed a missile similar to MICA and AIM-120 AMRAAM, but a bit heavier than MICA and considerably lighter than AMRAAM. First displayed in 2001, the Derby missile is similar to the Kentron R-Darter, which was also first displayed in 2001. The missile has a length of 3.62 m, a body diameter of 0.16 m, and a launch weight of 118 kg. There are four moving delta control fins at the nose, with two rectangular moving control fins just behind, as with Python 4. At the rear of the missile are four clipped-tip delta wings. The missile can be launched from the Python 4 wing Pylon and launcher. It is reported that Derby has a maximum range of 60 km in the air-to-air role. The missile has been cleared for carriage on F-5, F-15 and F-16 aircraft, and there have been in excess of 40 test flights. Present reports state that Derby has not yet entered service in Israel, but has been exported. It is possible that the R-Darter programme is an export version of Derby, alternatively though exports of Derby rnay have been made to Brazil or Chile. In 2001 there was an unconfirmed report that Derby has been offered for export as a surface-to-air missile with a vertical launch capability, for use from land or ships.

JAPAN

Tan-SAM **2/Chu-SAM**

Japan is developing an anti-aircraft and anti-missile defence system, with a range between 30 and 50 km, and with engagement altitudes up to 10 km. Research on the new missile, known as Chu-SAM or Tan-SAM 2, started in 1989 and was followed with a development contract starting in 1994. The missile will be capable of deployment against aircraft, cruise missiles and short-range tactical ballistic missile threats. The new missile system may be being developed for use from land vehicles and ships. Tan-SAM 2 has four clipped-tip delta fins at the nose, and four similar sized fins at the rear. The missile is reported to have a maximum speed between M2.0 and M3.0, and to have a two-phase sustainer motor that can coast between the two thrusting sequences. Tan-SAM 2 will have an active radar seeker with track via missile initially, possibly similar to the seeker developed for the XAAM-4 air-to-air missile. A later version is expected to have a dual-mode active radar and imaging IR seeker. The missile has inertial guidance with mid-course command updates, and a terrain-following capability. Tan-SAM 2 is designed to be able to engage over-the-horizon low level targets. It is planned that six missiles will be carried on a wheeled launch vehicle, with the missile canisters raised to the vertical before the missiles are launched. A typical battery would comprise a surveillance/engagement radar, four to six launch vehicles, a fire-control centre and a communications vehicle. Contracts were placed in 1995 to develop side thrusters for this missile, similar to those used on the FSAF Aster and PAC-3 missiles. Research into integral rocket ramjet motors at JDA's Third Research Centre in Tachinawa might be associated with a longer range variant of Tan-SAM 2. Programme management is with the Technical Research and Development Institute and the prime contractor is the Mitsubishi Electric Corporation. Flight trials were planned to start at the White Sands Missile Range in the USA in 2002, and a date of 2003 has been suggested for the start of initial low-rate production.

PAKISTAN

Anza **Mk 3**

The development of the SAM system called Anza Mk 1 and 2 was first reported from Pakistan in 1989, and it was suggested that the programme was based upon the Chinese QW-1 Vanguard shoulder-launched IR guided missiles. In 1996, a report from Pakistan stated that an Anza Mk 3 SAM system was in development, similar in performance to the Russian SA-9 'Gaskin' or SA-13 'Gopher' missiles. The new system would be vehicle-mounted, and was being developed by the Khan Research Laboratories. A separate report suggested that the Anza Mk 3 would be capable of intercepting Prithvi SRBM. The Pakistan Navy bought Chinese LY-60 surface-to-air missiles, and it is possible

that the Anza Mk 3 project has been halted or changed.

RUSSIAN FEDERATION

ABM4

Reports from the Russian Federation in late 1994 indicated that a new interceptor for use against inter-continental ballistic missiles had been developed. The designator for this new missile is not known, but it is believed that it will replace both SH-08 'Gazelle' and SH-11 'Gorgon' interceptors from the existing Moscow ABM-3 system. The new missile may have a nuclear or HE warhead, and could be used for both long-range and short-range intercepts. An unconfirmed report in February 2002 suggested that the new interceptors are in storage, with 100 missiles built, but will be deployed in the near future.

ASAT/BPI

An unconfirmed report states that the Russian Federation has converted some MiG-31 'Foxhound' aircraft to carry and launch an anti-satellite missile, similar in concept to the US ASM-135 system, but based upon the AA-9 'Amos' missile. It is reported that this system has been tested since 1987 and that several MiG-31 aircraft have been modified with wing leading-edge extensions and tip-end plates to improve stability at high altitude. It is assumed that this programme will be held pending any future ASAT tests by the USA. A further unconfirmed report in 1996 suggested that a number of AA-9 missiles had been modified for use from the MiG-31 aircraft as a ballistic missile boost phase interceptor. However, further reports in 2000 indicated that this project had been terminated as no adequate performance could be achieved.

Directed Energy Weapons (DEW)

DEW research has been carried out in the Russian Federation since the early 1960s. particularly with lasers. Both nuclear and solid propellant generators have developed several MW power levels. A major test facility was located at Sary Shagan in Kazakhstan. Russian programmes have been reported for ground-based, airborne and space-based laser weapons. It has been reported that a tracked and armoured vehicle with a ground-based laser was developed in the mid-1980s for use against aircraft and missile targets, but these have not been displayed. It has also been reported that the Russians conducted several tests using a ground-based laser to disable sensors carried on satellites in low earth orbit.

Middle Range Air Defence System (MRADS)

Almaz NPO first released information on a new air defence system in 1998, named MRADS. It is not clear which missiles are going to be offered with this system though, and there are believed to be at least two options. It is believed that the MRADS will use the Fakel MKB designed 9M62 missile used in the S-400 system, which has a range of 40 km. Alternatively though, the Vympel R-77-3PK vertical launched SAM version of the AA-12 'Adder' air-to-air missile may be offered. Both missiles have active radar seekers. A redesigned wheeled TELAR vehicle was displayed in November 2001, mounted on a 10 tonne truck chassis with four axles, and air transportable in 11-76 and An-124 aircraft. Ten missile canisters can be carried in a re-loadable VLS pallet on the rear of the TELAR. The TELAR has a multifunction surveillance/engagement phased array X-band radar, together with ECCM and IRCCM systems. The radar rotates mechanically through 360° in azimuth, and is electronically scanning in elevation. The radar can track up to 50 targets, and the system can engage eight targets at the same time. It is believed that this is a private venture development, and that the system has not been purchased by the Russian forces. No export orders have been announced.

R-77-3PK

It was reported that a SAM variant of the AA-12 'Adder' active radar guided air-to-air missile, with the designator R-77-3PK, was being developed by Vympel NPO. The initial proposal was that the standard AAM would be used, with a weight of 175 kg and a range of 25 km in the SAM role. A later version of the missile, believed to weigh 225 kg and using a ramjet motor, could give a range of up to 100 km. Funding difficulties had slowed the production start of the AA-12 missiles, following the transfer of production from the Ukraine to Russia in the early 1990s. AA-12 had still not entered service in Russia by 2000, and although export orders for China, India and Malaysia have been reported, there is no confirmation that any new build missiles have been delivered. A report in January 1999 suggested that the SAM variant of the AA-12 missile would be fitted to wheeled vehicles, similar to the US NASAMS, which deploys AIM-120 air-to-air missiles in the SAM role. In November 2001 it was reported that the missiles might be offered with the MRADS, as an option in place of the 9M62 missile.

SA-NX-? Underwater-to-air missile

The Russian Federation is believed to have a new missile development, intended to provide submarines with an improved defence against ASW helicopters and aircraft. The Russian Navy fitted short-range SAMs on pedestal mounts in the sail of submarines from the late 1970s. including Typhoon, Akula, Sierra 1 and 2 and Kilo class submarines all using either SA-N-5 or SA-N-8 'Grail' IR guided missiles. SA-N-10 'Gimlet' missiles followed as replacements for the earlier missiles. The new missile will probably be fired from the sail, while the boat is submerged, using data gathered from a periscope TV camera or from a towed sensor. The missile can also be presumed to have autonomous guidance after launch. Unconfirmed reports suggest that development tests started in the early 1990s. but that funding problems have delayed its entry into service.

S-500

There have been unconfirmed reports since 1996 from the Russian Federation that a successor to the SA-10 'Grumble' and SA-12 'Gladiator/Giant' systems is in development. Specifically aimed at defence against ballistic missiles with ranges up to 3,000 km and against AEW, AWACS and jamming aircraft, this system may have the Russian designator S-500. It is possible that the missile will be similar in performance to the US THAAD system, but with an additional role against large high flying aircraft. There has also been some confusion about the S-400 system, as reports indicate that there will be three different missiles used in the new system. The S-400 system has been displayed with two missiles, the 9M96 and 9M96/2. However, it has been reported that a third missile with a range of 400 km will be added. At the present time, it is not clear what the designator will be for the new 400 km range missile. It is possible that the 400 km range missile might be the initial missile with the new S-500 system, or that a separate programme is developing another missile for the S-500 system. A report in November 2001 stated that China had tested a 400 km range SAM, and that China was also funding the Russian S-500 programme, but this has not been confirmed.

Sosna-R

A new surface-to-air missile was displayed by KB Tochmash in 1997, named Sosna-R. In 1999, it was reported that the missile has the Russian designator 9M337, and that it is similar in appearance to the Pantsir-SI missile developed for the SA-19 'Grison' missile system upgrade. The Sosna-R missile can also be used with the naval Palma air defence system. The two-stage missile is 2.2 m long, has a body diameter of 0.07 m, the boost motor assembly has a diameter of 0.13 m, and a whole missile has a launch weight of 25 kg. The warhead weight is 5 kg HE and is believed to release a group of fragmented rods. There are two stages for the Sosna-R missile, both with solid propellant motors. The maximum speed for the missile is 1,200 m/s, and the missile takes 11 seconds to reach 8 km. Initial guidance during the boost stage is by radio command CLOS, but then during the sustainer second-stage flight, the missile becomes a laser beam rider, similar to the UK Starstreak (HVM) guidance method. Sosna-R has a minimum range of 1.3 km, a maximum range of 8 km and a maximum intercept altitude of 3.5 km. The launcher has a round electro-optic sighting assembly, with a FLIR, laser range-finder and TV camera. There are no known exports and it is believed that the system has been offered to the Russian Army as a possible supplement to the SA-19 'Grison' system.

Vega SAM System

A short range surface-to-air missile system, named Vega, was first exhibited by Kolomna KBM in 1993. The Kolomna bureau has developed the SA-16 and SA-18 shoulder-launched SAMs, as well as the AT-3, AT-6 and AT-9 anti-tank missiles. Vega can be mounted on a vehicle or on the ground, and includes a small phased-array surveillance radar with a range of 15 km against a small aircraft or cruise missile target. The missile has a launch

weight of 24 kg, a 7.2 kg HE warhead and a maximum speed of 1.0 km/s. The minimum range is 800 m, the maximum range 12 km, and the maximum intercept altitude is 8 km. Guidance can be dual mode or single mode, using CLOS with a laser beam or IR tracking. The Vega system was offered for export in 1998, but it is not known if it is in service in the Russian Federation or if there have been any exports.

Kentron SAM

In 1996, Kentron (part of Denel) were reported to have proposed a SAM variant of their ramjet-powered, long-range air-to-air missile. The SAM variant would be vertically launched with a TVC system added to the boost motor assembly. The design was believed to be based on the SAHV missile (see separate entry), but the ramjet motor is expected to give a maximum range of 35 to 50 km. In 2000. it was stated that this proposal was still awaiting funding, and that the long-range air-to-air missile project had also been delayed. However, the R-Darter active radar guided air-to-air missile, was displayed in 2001. This missile is similar to the Israeli-developed Derby AAM, and might also be offered in the SAM role for use from land or ships, with a vertical launch capability.

TAIWAN

Tien Chien 2 (Sky Sword 2)

The Tien Chien 2 active radar guided air-to-air missile was developed by CSIST. The first flight trial was made in 1993, and the missile is believed to have entered service in 1996. The missile is similar in size and shape to the US AIM-7 Sparrow missile. There are four fixed wings at the centre and four moving control fins at the rear. The missile has a length of 3.6 m, a body diameter of 0.19 m, and a launch weight of 183 kg. There is a 22 kg HE blast/ fragmentation warhead, and the missile has a maximum range of around 60 km. In 2001 there were reports that land- and ship-launched versions were being developed, with some possibly for fitting to upgraded Knox class frigates. The SAM versions would have a range of around 40 km.

UKRAINE

SAM

A report in 1996 stated that Ukraine was developing a new surface-to-air missile system to replace SA-3 'Goa' and SA-IO 'Grumble' missiles. No further details were made available, and there have been no further reports of this development programme up to April 2002.

UNITED KINGDOM

Royal Navy laser weapon

Laser guns, designed to dazzle the pilots of attacking aircraft, were deployed on Royal Navy warships from 1982. The system, known as a 'Laser Dazzle Sight' (LDS) was reported to have had a range of about 5 km and was primarily intended to make the pilot abandon his attack, but at close range the system might inflict serious eye damage. The laser dazzle sights were apparently developed from industrial lasers and were initially quite primitive in concept, being manually aimed and deployed on improvised stands, such as tripods. It is believed that improved systems have now been developed, but that the UK has not put these systems into service. A report in 1996 suggested that the UK may fit a laser weapon to ships, to defend against aircraft and anti-ship missiles that use TV or IIR seekers.

UNITED STATES OF AMERICA

ADSAM/ADAAM/SWORD

The US Army and Marine Corps were planning a follow-on system to the MIM-23 HAWK, with capabilities against aircraft, helicopters, air-to-surface missiles, cruise missiles, unmanned air vehicles and tactical ballistic missiles. The follow-on system, to protect manoeuvre forces, was known as Corps SAM. Concept definition study contracts were awarded to six contractor teams in 1992, but demonstration/validation was delayed pending clarification of priority and funding for this programme. In 1995, the USA signed an initial agreement to participate in the international MEADS programme (see entry) and the Corps SAM requirement was integrated within the MEADS programme. However, if US funding for MEADS is terminated, then there are several proposals that might be adopted as a replacement for the US Army.

An Air Directed SAM (ADSAM) would use an airborne radar or a radar mounted within an aerostat for surveillance and engagement tasks, but using a surface-to-air missile, probably PAC-3. An Air Directed AAM (ADAAM) would use an airborne radar or an aerostat mounted radar to direct long range AAMs, such as an upgraded AIM-I20. A third proposal, from the US Army, is for a Short range missile With Optimised Radar Distribution (SWORD), which was reported in early 1998, and has been suggested as a low cost alternative to a ground-based laser for defence against surface-to-surface rockets. SWORD would use a small missile with a length of 2.0 m, a diameter of 0.095 m, and a weight of 23 kg. A combined boost/ sustain solid propellant motor would give a maximum range of 8 to10 km. Although designed to be a hit-to-kill missile, it is believed that a small warhead might also be fitted. The missile would have an IMU, but would essentially have CLOS guidance with six lateral thrust motors for terminal phase agility. The missile has been designed for use from existing Bradley, MLRS M270 and Avenger launch vehicles, with an M270 carrying two 54 missile pods. A separate interferometer phased-array engagement radar would be vehicle-mounted, probably using X or Ku band, with 360° coverage, a range of 25 km and providing command guidance to intercept for the missiles via an RF uplink. The missiles would have a transponder in the rear, so that the engagement radar can track both incoming targets and outgoing interceptor missiles. A possible in service date for SWORD would be 2006.

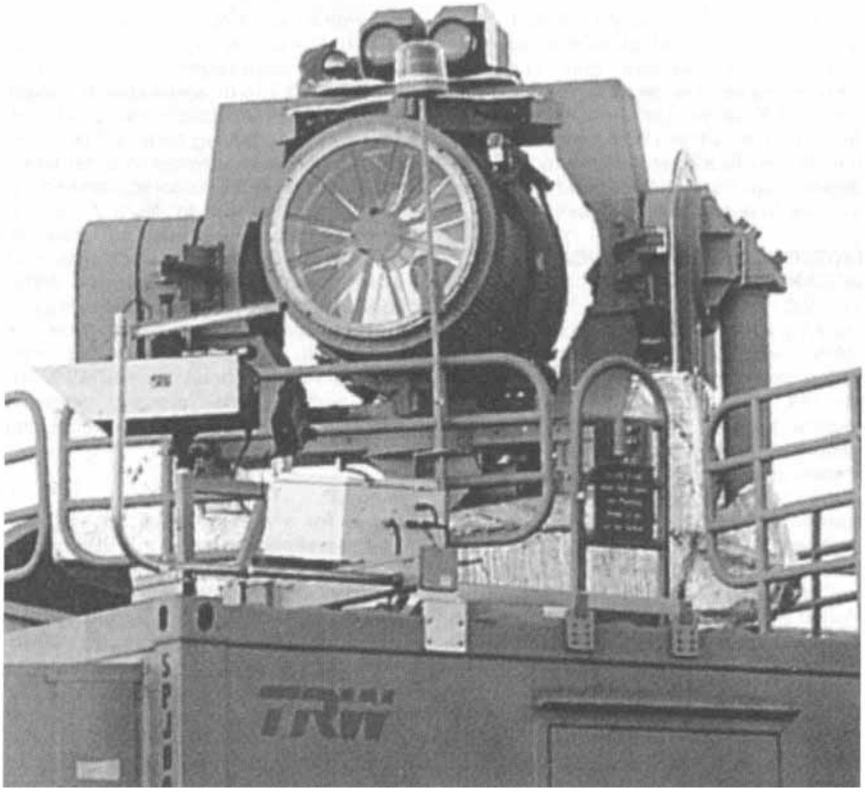
DARPA and Northrop Grumman are jointly testing a version of the ADM-160 Miniature Air Launched Decoy (MALD), modified as the Miniature Air Launched Interceptor (MALI) for possible use against low-level cruise missiles. The joint research programme was funded in 1999, and the first flight test was made in November 2001. MALI has a length of 2.5 m, a body diameter of 0.175 m, and a launch weight of 50 kg. There are folding wings at mid-body, and four moving control fins at the rear. The missile is powered by a Hamilton-Sundstrand TJ-50M turbojet, providing a cruise speed of up to M 1.2, and a maximum range of 100 to 350 km. Guidance is INS/GPS with a datalink, and several terminal seeker options are being considered, including active radar, imaging IR and passive radar seekers. MALI is expected to be ground launched from small vehicles such as the HMMWV, or from aircraft. The present research programme is expected to continue until the end of 2003.

KE-ASAT

Studies for a ground-based missile anti-satellite weapon restarted in 1988, under US Army direction. A development contract was awarded to Rockwell International (now Boeing) in 1990 for the KE-ASAT programme. Early designs of KE-ASAT are believed to have been for a 12,000 kg missile, with a 45 kg kill vehicle based on an earlier space-based interceptor proposal. It is reported that this system would have had a capability to disable satellites in orbits up to about 2,000 km. About 150 KE-ASAT were expected to be ordered for delivery from the year 2000, but the demonstration/ validation programme was zero funded in 1993. A technology programme has continued from 1995 and prototype kill vehicle tests were carried out in 1994 using a visible light seeker with the kill vehicle rigidly attached to a test stand. A hover test was made in August 1997. Two flight tests were planned, using STARS (refurbished A-3 Polaris boost motors) or refurbished Minuteman II motors and US Army kinetic kill vehicles fitted with a large mylar sail to damage but not break-up an enemy satellite. A soft kill mechanism is also being considered for the kill vehicle, using a chemical or paint spray to disable the optics of a satellite without physically breaking it up. The Boeing contract was amended in January 1999 to remove the two flight tests, to build three flight test vehicles to be prepared for flight demonstrations, but not to flight test the vehicles. This part of the programme is due to be completed in 2002, and by April 2002 no decision had been announced with regard to the flight tests.

Ground-based laser/THEL

TRW proposed a ground-based laser weapon in 1991, called GARDIAN, for use against cruise missiles, air-to-surface missiles and UAVs. This system would have had a 200 kW chemical laser mounted on a wheeled vehicle, capable of delivering 50 shots against multiple threats. The US Army have had a programme using the High-Energy Laser Range System Test Facility (HELSTF) researching laser weapons lethality for future GBL requirements. Russian research into solid rocket motor magnetohydrodynamic (MHD) electric power generators may well provide sufficient power for mobile ground-based



The static THEL test facilitv at White Sands Missile Range (TRW) 01 10059

laser weapons, and a 15 MW generator was tested in the USA in 1996.

The TRW/US Army programmes on GBL were combined with an Israeli laser lethality project called Nautilus and in 1995, the Tactical High Energy Laser (THEL) programme was funded. Tests were carried out using the MIRACL megawatt class deuterium fluoride chemical laser system and Sea Lite beam director at White Sands Missile Range in February 1996 against unguided Russian artillery rockets. Israel had a requirement for a defensive system for use against Russian Katyusha rockets, similar to those used by Hezbollah against targets in Israel.

The US Army has no validated requirement for a GBL system at present, but expects to conduct a system demonstration by 2006 to evaluate options for disrupting EO sensors and destroying aircraft, UAVs, missiles and rockets.

In July 1996, the Sea Lite beam director successfully tracked a boosting rocket in its initial launch phase (a Black Brant sounding rocket). In July 1996, the USA and Israel agreed to jointly fund a contract for a contractor team to build a prototype THEL mounted on a vehicle, with tests starting in 1997. THEL uses a deuterium fluoride chemical laser, with multiple mirrors to point the laser beam at closely spaced multiple targets. The surveillance radar is based upon the L-band Green Pine radar developed by Elta in Israel for the Arrow programme, and a prototype radar tracked a cluster of 55 rockets in a test in early 1998. The engagement radar cues a FLIR, and then a low-power laser illuminator and range-finder is used to establish accurate tracks on individual targets before hand-over to the high-power laser to destroy the targets. The Katyusha rockets are 3.0 m long, have a diameter of 122 mm, and are flying at around 340 m/s (M1.O) during the later portion of their trajectories. It is expected that THEL will have a maximum range of 5 to 10 km. The THEL advanced concept demonstrator programme has experienced delays, and a contract re-negotiation was concluded in June 1999 between TRW, the US Army and the Israeli MoD. High power laser tests started in July 1999 at TRW, and the prototype system was transferred to the White Sands Missile Range for full intercept tests against Katyusha rockets. Thirteen successful intercepts were made between June and October 2000, against single and multiple targets. THEL was a static installation with a weight of over 180,000 kg, and was not designed for operational use.

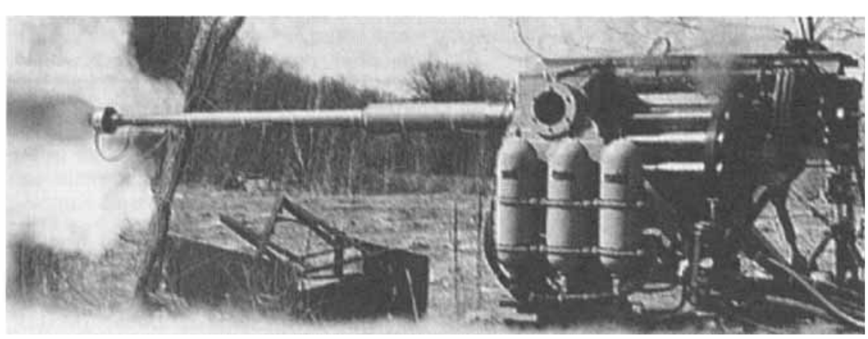
Following these tests, it was planned that the system would then be moved to Israel for further operational evaluation, but it is not clear if this will be with similar designs or a lighter and mobile version.

The US Army has plans to develop THEL into a much lighter (18,000 kg) Mobile THEL (MTHEL) system, small enough to be C-130 Hercules transportable. Israel is reported to prefer a larger system fitted to a wheeled truck, probably with a weight of 36,000 kg. Joint TRW and Rafael proposals are being prepared for the follow-on system. This system may be evaluated from 2003 to 2007 for fitting onto a M119 chassis, with three vehicles for each MTHEL fire unit, a launcher vehicle, engagement radar vehicle, and a refueling vehicle. This new system might have a solid-state laser, with a power up to 100 kW if this is achievable in the timescale. A test was made in October 1997, using the MIRACL high energy laser located at White Sands Missile Range, to assess the damage that would be caused to a satellite in low orbit, the test being conducted against a USAF satellite with electro-optic sensors on board.

A Solid State Heat Capacity Laser (SSHCL) programme has been funded from 1997, using a Lawrence Livermore National Laboratory design, with General Atomics leading an industrial team for the US Army project. The first system used a flashlamp pumped laser rated at 10 to 13 kW, delivering 500 J pulses at 20 Hz. Laboratory tests on a 100 kW pumped diode laser are planned to start in 2004, and this system will then be mounted in a HMMWV with a capacity for ten shots, and reloading within 2 minutes.

Hypervelocity Guns (HVG)

A railgun was first successfully demonstrated in the USA in 1980, when Westinghouse accelerated a 0.3 kg mass to over 4 km/s. Developments since 1980 have improved power generation, power storage, high current switching and the achievement of multishots. A small 6 mm disc was accelerated to 15.8 km/s in 1994 and current research programmes are aiming at accelerating a 5 kg projectile to 2.5 km/s. There are three basic HVG designs; the coil gun; the rail gun and the electrothermal gun. In addition, there are several hybrid solutions, including using an electrothermal gun to pre-accelerate a projectile into a tandem rail gun and adding a solid propellant charge (chemical) before acceleration or after leaving the HVG. Ground- and ship-based systems have been researched since 1983, for use in air defence, ballistic missile defence and as an offensive gun system against ships or armoured vehicles. Two major problems have hindered the development of HVG, the need to carry high (3 million amperes) current loads, and the size of capacitor



A demonstrator 60 mm electrothermal-chemical gun, developed by FMC for the US Navy
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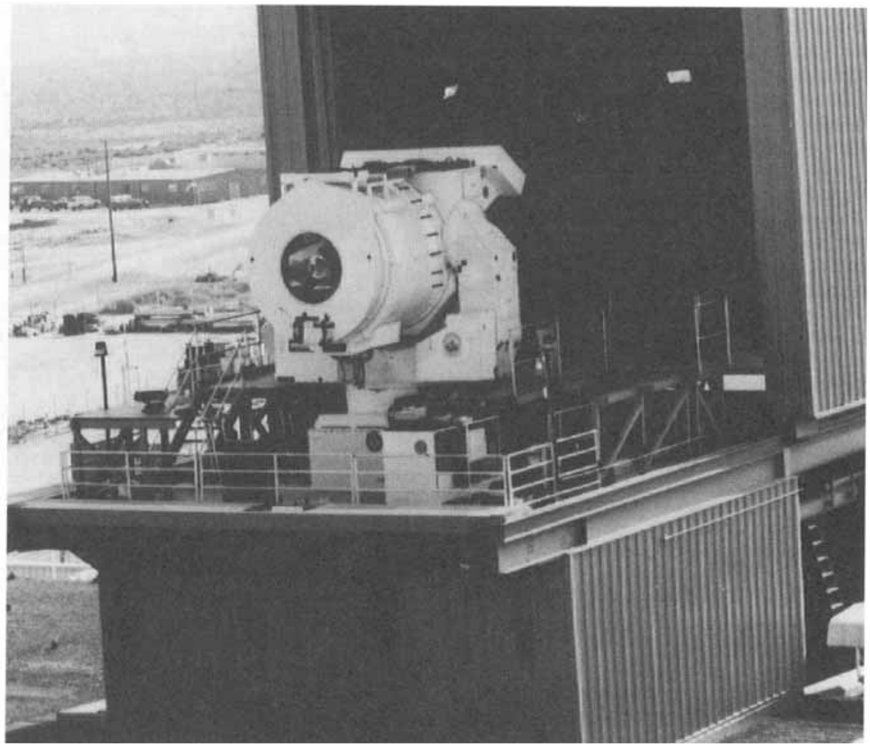
storage systems. More recently the US has researched compensated pulsed alternators (compulsators) to store the electrical energy, using high speed rotors and electrical pulse generators. Developments have included a 60 mm diameter electrothermal-chemical gun for the US Navy and a 120 mm coil gun for the US Army. The 60 mm HVG is being considered for use as a close-in defence weapon for ships, firing 3.5 kg command-guided projectiles at 4 rounds/s. A 90 mm rail gun is being developed for trials in 2003, planning to accelerate projectiles with 8 MJ of energy at speeds up to 2.5 km/s. This gun should have a range exceeding 5 km, and be able to fire at around 20 to 30 rounds per minute. A joint research programme between USA and Israel, examined a 105 mm solid propellant electrothermal-chemical (SPETC) gun with trials that started in 1993, aimed at using a command guided 5 kg projectile launched at 2.0 km/s. The projectiles have to withstand very high acceleration, up to 100,000 g.

The ETC programme has continued in the USA, and it is possible that the project could be selected for fitting to the US Army Future Combat System. Proposals in 2001 suggested a 105 mm ETC gun could be fitted onto a 20 tonne vehicle, with a range of up to 50 km against soft ground targets. Against helicopters or UAV the range would be 12 km, and against slow moving aircraft around 20 km. For use against tanks the range would be further reduced to 5 km. The rounds could be fired at a rate of 20 to 30 per minute, and up to 50 rounds would be carried by the launch vehicle.



The US Navy ship-based laser trials facility at the White Sands Missile Range, showing an early experimental system used against moving aircraft and missile targets in the late 1980s

Compact Kinetic Energy Missile (CKEM/LOSAT)

The US Army are participating in an Advanced Concept Technical Demonstrator (ACTD) programme with a kinetic energy missile for use against tanks, bunkers, helicopters and slow flying aircraft. This programme is called Line Of Sight AntiTank (LOSAT), with Loral Vought Systems (now Lockheed Martin Missiles and Fire Control) as prime contractor. The LOSAT system uses the Kinetic Energy Missile (KEM) mounted on the chassis of the armoured gun system or on an HMMWV. A FLIR sensor acquires the target and the missiles are carried in either 4 or 12 canister packs. The KEM is 2.85 m long, has a body diameter of 0.16 m and a weight of 77 kg. The missile has a peak velocity of over 1.5 km/s and carries a simple penetrating rod with no warhead or fuze, relying on kinetic energy to pierce the armour of a tank or destroy a helicopter target. The KEM is CLOS-guided, using the FLIR on the launch vehicle to track the target and the missile, with guidance commands sent by datalink to the missile in flight. The missile is controlled by a cluster of solid propellant thrusters mounted axially across the missile body just forward of the centre, similar to the method used on the US PAC-3 missile. The missile is expected to have a maximum range of 10 km.

The HMMWV and LOSAT system are to be air transportable by C-130 Hercules aircraft, and broken down loads could be slung under CH-47 or UH-60 helicopters. An early user evaluation is planned by the 82nd Airborne Division, with 13 launch vehicles and 144 missiles to be tested during 2003 and 2004. Present plans have been reported to total 170 launch vehicles, which may be ordered with LRIP probably starting in 2004.

The US Army are researching a follow-on programme, known as the Compact Kinetic Energy Missile (CKEM). Technology demonstrator programme proposals were requested in September 2000, for fitting to the Future Combat Vehicle (FCV). A four year risk reduction and initial development programme is expected to start in 2002. This missile will be similar to KEM/LOSAT, but with a considerably smaller size and weight. The missile length is expected to be 1.2 m, body diameter 127 mm, and weight 23 kg. The missile boost motor will burn for around 0.3 seconds, and will contain 15 kg of solid propellant. The maximum speed is planned to be 2.2 km/s (M6.5), with a maximum range of 5 to 8 km. The guidance and control is expected to be similar to that for KEM/LOSAT, and CKEM will have a tungsten penetrator and no warhead, but with 10 MJ of energy at impact. A projected in-service date for CKEM is reported to be between 2012 and 2018.

A LOSAT test launch from a HMMWV in 1996 (US Army) 0110055

Ship-based laser

The US Navy has been using the MIRACL (Mid-Infra-Red Advanced Chemical Laser) located at the White Sands Missile Range for tests of potential ship-based laser weapons for use against missile and aircraft threats. This system operates at about 2.8 μm and is reported to be producing powers over 1 MW, with successful tests against drone aircraft and actual SS-N-2 'Styx' missiles. Hughes (now Raytheon) and Signaal proposed a close-in weapon laser as a successor to their Phalanx and Goalkeeper gun systems in 1995, with a 200 kW laser power source based on a flywheel system. Free electron laser weapons have also been proposed to defeat the sensors on anti-ship missiles, and it was planned that the HELSTF laser test facility at White Sands would be used for ground lethality tests as well as flight demonstrations.

HELWEPS (High Energy Weapon System) has been proposed by TRW as a chemical laser weapon for use against

anti-ship missiles and an outline design for a 'Ticonderoga' class cruiser indicated a total system weight of 15 to 25 tonnes. If a mobile version, MTHEL, of the ground-based THEL system is developed, then a similar system could be fitted to ships.

Space-based laser

The mid-1980s space-based laser concept envisaged a constellation of weapons in orbit covering the known threat ICBM fields, so that the laser weapons could destroy the ballistic missiles during their boost phase. These weapons would have required around 100 MW to be generated in space, with vibration and exhaust gas dispersal problems to be solved as well.

Originally planned as the Zenith Star project and later reduced to Star Lite, this programme would have tested a 20,000 kg system using an Alpha hydrogen fluoride chemical laser, operating at several wavelengths around 2.7 µm. The first ground trial of the Star Lite Alpha laser was made in 1989, with the system demonstrating weapons quality beam propagation at over 1 MW in 1990. The programme was slowed after 1989, but the funding was increased in 1997 to include integration and ground tests on the Alpha laser and the Large Advanced Mirror Programme (LAMP), with the Large Optical Demonstration Experiment (LODE) beam control system. Two six-month concept definition studies were awarded to teams led by Lockheed Martin and TRW in April 1998. In February 1999, the USAF announced plans to contract a single joint industry team, with Boeing, Lockheed Martin and TRW participating. This contract was awarded in February 2000 for a technical ground demonstration programme, which if successful might lead to an integrated flight experiment known as the SBL IFX, now planned for 2012 to 2015. Four full power tests of the Alpha high energy laser beam propagation using the 4 m diameter large advanced mirror to demonstrate pointing, jitter and wavefront control were completed in 1998. A test in December 2000, compared the chemical flow rates with output powers and beam uniformity. The major components of the space-based laser project are the high-power laser (TRW), beam control (Boeing), and beam direction with spacecraft integration (Lockheed Martin). Any space-based laser could be expected to have a range between 1,000 and 5,000 km and could be used for other missions in addition to destroying ballistic missiles.

A proposed constellation would have up to between 15 and 50 space-based laser platforms, located in 400 to 1,000 km altitude orbits. The SBL for the IFX demonstration will be tested in a new facility to be located at Stennis Space Centre, Mississippi, with the first ground tests at this facility expected by 2007. The ground test will be on a lower power laser system, probably with a range of 200 to 300 km.

YAL-1 Airborne Laser (ABL)

Airborne Laser trials were made by the USAF between 1970 and 1983 on a KC-135 aircraft known as the Airborne Laser Laboratory. These trials used a gas dynamic laser, and successfully destroyed five AIM-9 Sidewinder air-to-air missiles and a BQM-34 target drone. A second programme is being carried out by MDA and the USAF, using a much larger airborne laser to be carried in a wide-bodied aircraft (Boeing 747-400F). This weapon is designed to destroy ballistic missiles, in the first instance during their boost phase. Secondary roles for the ABL could be the early warning of ballistic missile launches, ballistic missile impact point prediction, cueing ballistic missile defence systems, cruise missile defence, the protection of high value assets (such as AWACS or Joint STARS aircraft), surveillance and the suppression of enemy air defences. It is possible that given a different sensor, the ABL could attack low-flying satellites. The aircraft will have six IRST sensors, based upon the system used in the F-14 Tomcat aircraft, to provide 360° coverage of missile boost motor plumes and to initiate threat tracks. An active ranging system, using a low-power carbon dioxide laser range-finder, would then lay onto the target a beam illuminator laser, with a power of 50 to 200 W. The beam illuminator would then be tracked by a camera, and adjusted by the fire-control system to put the high-energy laser weapon onto the selected aimpoint on the target after adjusting for jitter and beam distortions. The large carrier aircraft would cruise at an altitude of about 45,000 ft, and the YAL-1 laser weapon would have a range of 50 to 400 km with each aircraft carrying sufficient laser fuel for 20 shots. Each aircraft would have a 2.65 m diameter laser turret mounted at the nose, with the laser production system located at the rear of the aircraft. The turret weighs 5,900 kg, and has a 1.8 m diameter fuzed silica window, with a 1.5 m diameter telescope inside to focus the high-power laser beam onto the target. The turret can move in azimuth over ±120°. It is believed that the final 14 module high-power laser will have a power output between 1 to 5 MW. Laser propagation and compensation experiments have been carried out since 1993. Two concept design contracts were awarded by the USAF in 1994, to teams led by Boeing and Rockwell (now part of Boeing), both using Chemical Oxygen-Iodine Laser (COIL) systems operating at 1.3 µm. The Boeing-led team, including TRW and Lockheed Martin, was awarded a contract in 1996 for programme definition and risk reduction. Boeing will provide the aircraft and weapons system integration, TRW the COIL laser, and Lockheed Martin Space Systems the nose turret, beam control and fire-control systems. This contract included design, integration and testing on one aircraft, with a successful intercept of a tactical ballistic missile planned for 2003.

An artists impression of a YAL-1 airborne laser system fitted into a converted Boeing 747 aircraft (USAF)
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The programme was re-assessed in 2002, and several changes made. The first ground test of a single flight standard laser module was made in June 1998, six beam modules will be used for the first flight tests, and eventually 14 modules will be put in series for the full power flight system. It is expected that engineering and manufacturing development will start in 2005/2006, with two development aircraft making flight tests. There are plans for the USAF to procure a total of seven aircraft, with the first aircraft in service by 2010.

Airborne Tactical Laser (ATL)

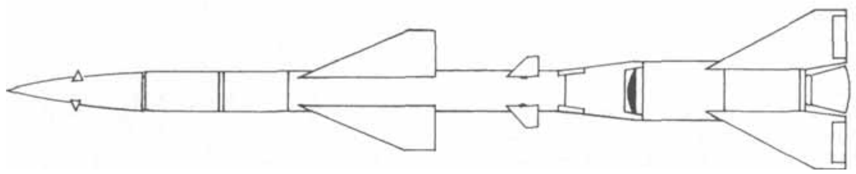
In 1997, Boeing proposed to the US Army and US Navy that an airborne tactical laser weapon system could be carried by aircraft and helicopters to defend against low-flying aircraft, UAV and cruise missiles. The initial proposal suggested that five to seven of the laser modules from the YAL-1 programme could be put together to produce a 300 kW weapon. This would use the same COIL as used in YAL-1, with up to 10 shots over a range of 10 to 20 km.

In 1999, a first proof of concept system operated at 20 kW, and it was proposed that a pallet with a weight of between 4,500 and 7,000 kg could be fitted into a C-130 Hercules aircraft or larger helicopters such as the CV-22 Osprey or CH-47 Chinook. The ATL could also be used against surface targets at shorter ranges. A test in October 2001 was made using the ground-based MIRACL at WSMR against a stationary vehicle, to measure power requirements and dwell times. The US Army Special Operations Command are leading an advanced technology demonstrator programme, which is planned to run until 2004. One flight test ATL will be built, probably with a power level around 75 kW.

CSA-1/HQ-2

Type

Short-range, ground-based, solid/liquid propellant, theatre defence missile.

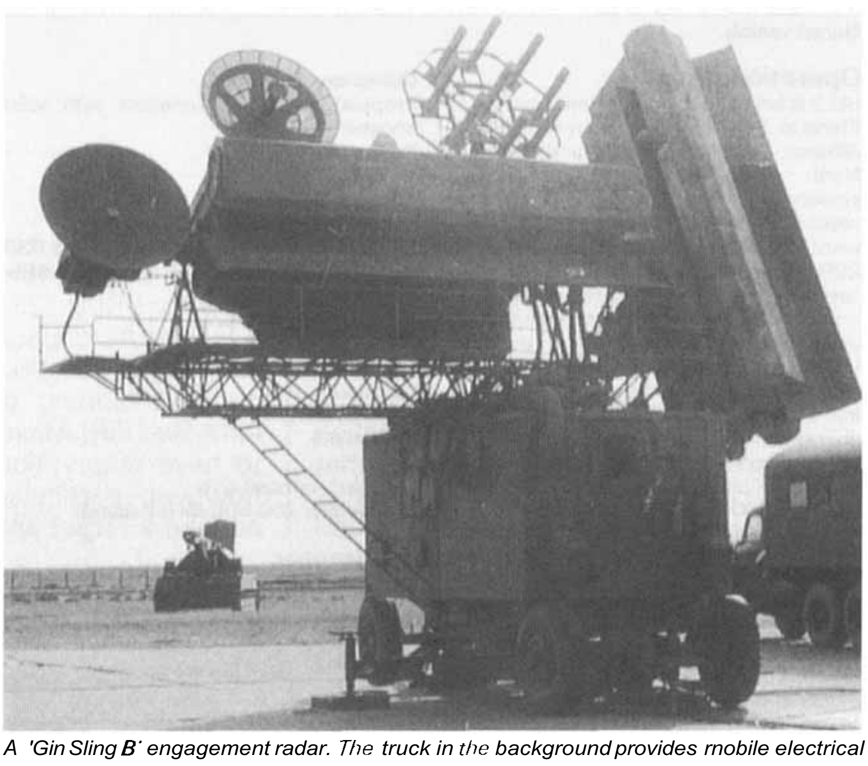


A diagram of the HQ-2 missile

Development

The Hong-Qi -2 (HQ-2) is believed to be a reverse-engineered copy of the Russian SA-2 'Guideline' SAM system, which was reportedly supplied to the Chinese in the 1960s. This is denied by the Chinese, who say it is a development of the HQ-1, which they manufactured between 1961 and 1964 from Soviet technical information supplied to them in 1959. They also say that the modified version of the HQ-1, designated HQ-2, was successfully test fired as early as June 1965. HQ-2 was given the NATO designator CSA-1. It is believed that design and development of HQ-2 was directed by the 2nd Academy, and manufactured by the 3rd Ministry of Machine Building at Shanghai. A modified HQ-2A was introduced in 1974, with an improved low-level performance and improved ECCM. Over the years there have been several improvement programmes to HQ-2, but **only** HQ-2B and HQ-2J versions have been detailed, and both are still offered for export. The missile electronics were upgraded in the 1980s to digital systems. The technical characteristics of the HQ-2B and -2J are similar; HQ-2B is a mobile system, while HQ-2J is static but transportable. There are believed to be HQ-2F and HQ-2P systems in service in China, but no details are available. These may have an increased high-altitude engagement capability, with an unconfirmed report suggesting up to 39 km (130,000 ft). In 1988, CPMIEC revealed that a successor to the HQ-2 was under development with the Chinese designator KS-1, with the capability of engaging multiple targets, and this system is believed to have entered service in 1996. There are also reports that the Chinese have tested HQ-2 in the surface-to-surface role, with a programme that started in 1985 known as Project 8610. The requirement was to develop a short-range ballistic missile from HQ-2, with a 500 kg warhead and a range of 180 km. It is believed that this was offered for export as the M-7 missile and entered service in China in 1992. The NATO designator for this missile is thought to be CSS-8 (see separate entry in Offensive Weapons section).

An HQ-2 surface-to-air missile just after launch 0008593



A 'Gin Sling B' engagement radar. The truck in the background provides mobile electrical power

Description

The HQ-2 is a two-stage missile with a tandem-mounted solid propellant booster stage fitted with four large clipped delta stabilising fins. HQ-2 is similar in shape and size to the Russian SA-2 'Guideline', with four delta nose fins, four clipped delta-wings at mid-body, and a third in-line set of clipped-tip delta moving control fins at the tail. The overall missile length is 10.84 m, the diameter of the booster stage is 0.65 m and that of the missile is 0.5 m. The weight of the missile at launch is 2,326 kg. The 130 kg warhead in the later versions is an improved design, with multiple fragments and a large scattering angle. At launch the solid fuel booster is ignited and this burns for 4.5 seconds, after which the booster assembly is jettisoned and the liquid fuel sustainer motor takes over. During missile flight a fire-control computer receives data from the 'Gin Sling' engagement radar, which is now tracking both target and missile. Alternatively, a TV or imaging IR tracker can be used in place of the engagement radar in heavy ECM conditions. The computer continually generates commands to guide the missile towards the target and these are transmitted over a UHF 700 to 800 MHz

digital datalink to four strip antennas mounted forward and aft of the centrebody wings. The onboard guidance unit receives these commands and adjusts the missile's trajectory using the movable rear control fins. The liquid fuel sustainer motor burns for a total of 22 seconds, with the HQ-2 attaining its maximum velocity of about M3.5 at an altitude of around 7,500 m. Later missiles have a maximum speed of M4.2. HQ-2 has a minimum engagement range of 7 km, a maximum range of 35 km; a minimum engagement altitude of 500 m and a maximum engagement altitude of 27 km. Later missiles may have been modified to have a maximum engagement altitude of 39 km. Once guided to the vicinity of its target, the weapon's fuzing system is activated and this detonates the warhead either by contact, RF proximity fuze or command signal. The RF fuze is an FM phase-comparison type. The complete HQ-2J system comprises: early warning and acquisition radars; a 'Gin Sling' (NATO designation) locally-built copy of the Russian 'Fan Song' engagement radar, which has been upgraded in terms of ECCM capability; fire-control system; six single rail launchers and six reload vehicles, each carrying three missiles. Up to three missiles can be salvoed and guided to a single target.

The HQ-2B is a mobile-launched version of the HQ-2J, carried on a single rail launcher mounted on the rear decking of a lengthened Type 63 light tank chassis. The basic fire unit for HQ-2B comprises: six mobile launchers; 24 missiles; one 'Gin Sling' engagement radar and display vehicle; one maintenance vehicle and associated power supply vehicles.

There is no information as to which radars actually support the 'Gin Sling' engagement radar. However, the engagement radar operates with and receives information from early warning/ acquisition and height-finding radars. Data on the range, altitude and bearing of the targets is passed to the appropriate 'Gin Sling' engagement radar over a landline or radio from the fire-control/command station.

The basic elements of the 'Gin Sling' radar are a pair of orthogonal 'trough' antennas, one horizontal and one vertical. The vertical antenna emits a fan-shaped beam, which scans from side to side and the horizontal antenna scans up and down. On the 'Gin Sling A, which is a straight copy of the Russian 'Fan Song A', both antenna beams cover a 10° arc and are about 2" wide. These beamwidths are thought to have been changed on the 'Gin Sling B'. The 'Gin Sling A has two parabolic antennas, one fitted on top and in the centre of the horizontal antenna, while the other is attached to the end. This end parabolic antenna is used to transmit UHF guidance command signals to the missile.

The 'Gin Sling B' has an additional antenna on the horizontal 'trough'. This is an octagonal open frame array with nine long thin tubes on it (eight round the edge and one in the middle).

A Chinese HQ-2B mobile surface-to-air missile, raised to the launch position on its tracked launch vehicle

Operational status

HQ-2 is believed to have entered service in China in 1967, and has been exported to Albania, Iran, North Korea and Pakistan. North Korea built HQ-2 missiles, presumably under licence, from 1978 to around 1985. Both HQ-2B and -2J versions were still being offered for export up to 2000. Throughout its life HQ-2 has seen several bouts of active service. The most notable of these were the shooting down of a number of Taiwanese-flown Lockheed U-2 high-altitude reconnaissance aircraft over mainland China in the late 1960s. and Iran's use of the HQ-2 from 1985 to 1988 during the Iran/Iraq war. It is expected that the HQ-2 systems are being phased out of service in China, and replaced by the KS-1, HQ-9 and HQ-10 missile systems.

Specifications

Length: 10.84 m
Body diameter: 0.50 m
Launch weight: 2,326 kg
Warhead: 130 kg HE blast/fragmentation
Guidance: Command
Propulsion: Liquid propellant with solid booster
Range: 35 km

Associated radars
Engagement radar: 'Gin Sling A
Frequency: Vertical antenna 3.025-3.030 GHz (S-band), horizontal antenna 2.965-2.990 GHz (S-band)
Peak power: 600 kW
Range: 60-120 km
'Gin Sling B'
Frequency: n/k
Peak power: n/k
Range: n/k

Missile Command Link
Frequency: 700-800 MHz (L-band)

Contractor

Chinese State Factories; but marketed by China National Precision Machinery Import and Export Corporation (CPMIEC), Beijing.

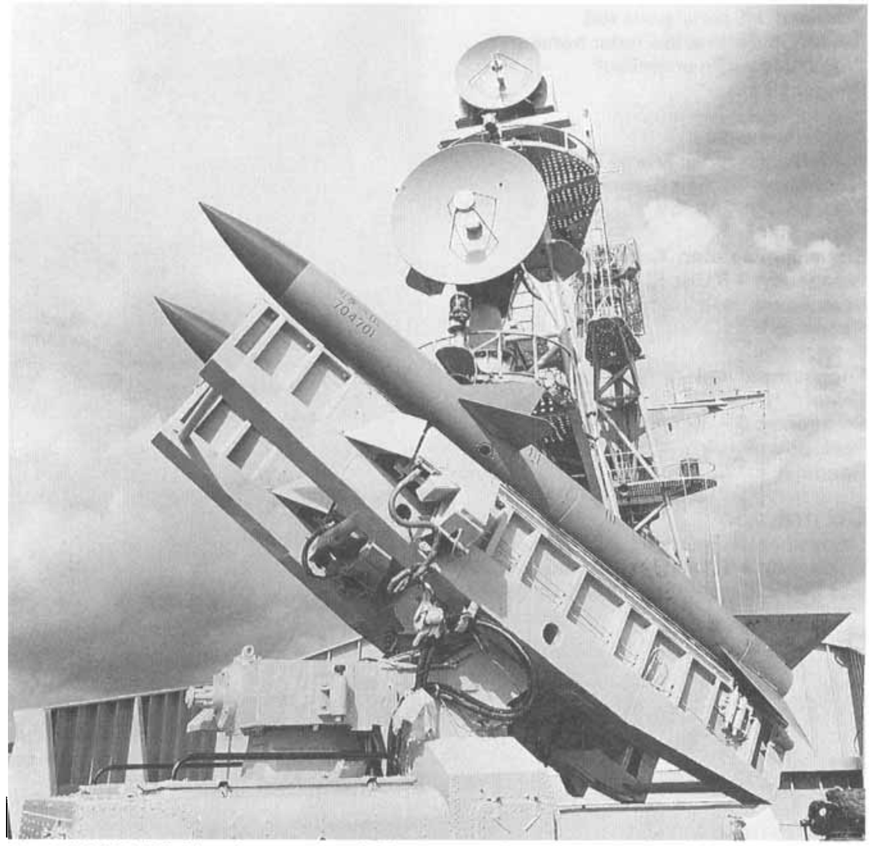
CSA-N-2 (HQ-61/RF-61/SD-1)

Type

Short-range, ground- and ship-based, solid propellant, theatre defence missile.

Development

The Hong-Qi-61 (HQ-61) system, sometimes designated SD-1 or RF-61 by the Chinese, was designed to meet the requirements of both the Chinese People's Liberation Army and Navy. Development of this missile system is believed to have started in the early 1960s as a PLA project with thedesignator HQ-41, but in 1966the programme became a joint Army and navy project and the designator was changed to HQ-61. The missile was first seen in public during the November 1986 Beijing Defence Exhibition. Photographs released in 1984 by the Chinese Navy revealed that two 'Jiangdong' class frigates were armed with a new SAM. This system was believed to be a naval version of the HQ-61 and has been given the NATO designation CSA-N-2. These frigates are no longer operational. Recent Chinese brochures also refer to the ship-based variant as SD-1. CSA-N-2 missiles are mounted in sextuple launchers on 'Jiangwei 1' class (type 053H2G) frigates. Reports in 1991 suggested that later ships of this class might have eight-canister CSA-N-2 vertical launch assemblies, but the 'Jiangwei 2' class ships have been fitted with LY-60 missiles.



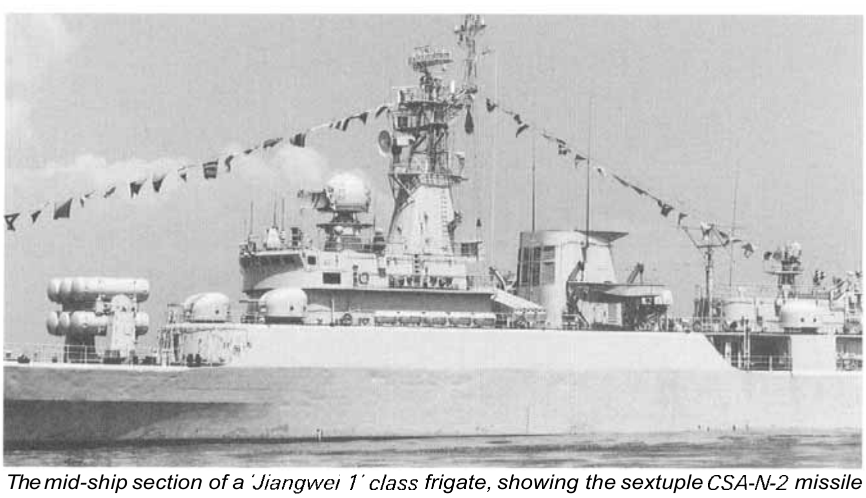
Two CSA-N-2 (SD-1) surface-to-airmissiles mounted on an open twin raillauncher, with an engagement radar antenna above 0008596

Description

The HQ-61 system was designed to engage targets flying at low to medium altitudes out to a range of about 10 km. The missile in many respects is similar to the US RIM-7 Sea Sparrow design, but is larger and heavier. It has a cylindrical body with four moving clipped delta-wings at mid-body, and four out of line larger fixed delta fins at the rear. The missile is 3.99 m long, has a body diameter of 0.29 m and weighs 320 kg at launch. The missile itself is single-stage with a solid propellant motor, has a continuous rod type high-explosive warhead and an RF fuze. The guidance system uses an X-band continuous wave semi-active radar homing head, which is reported to have some Electronic Counter CounterMeasures (ECCM)features including home-on-jam. A typical ground-based battery of the HQ-61 system consists of four launcher vehicles each with a twin launcher aft, a Type 571 surveillance radar, an engagement radar and a command centre. It is believed that the HQ-61 system can only engage one target at a time, and has an engagement altitude envelope of between 50 and 8,000 m. The minimum range is 2 to 3 km, and the maximum range is 10 km.

The Type 571 is a L-band surveillance radar and, although apparently operating in a different frequency band, it bears a striking resemblance to the Russian 'Flat Face'target acquisition radar used with the SA-3 'Goa' SAM system and, with its two elliptical parabolic lattice reflectors mounted one on top of the other, is probably derived from the latter. The speed of rotation is 3 or 6 rpm. Other features include moving target indication and frequency-hopping agility. According to the Chinese, the Type 571 radar has been designed specifically for low altitude warning and displays both the slant range and azimuth of aircraft targets detected. The naval surveillance radars are believed to be 'Knife Rest' C-band systems.

No details of the Continuous Wave (CW) engagement radars have been given, although the photographs released show a dish-type antenna with a TV camera mounted coaxially to the right for use in an ECM environment, or passive operations during clear weather engagements. The naval engagement radars are 'Rice Lamp' or 'Fog Lamp' X-band systems, also with a TV camera system, mounted forward of the bridge and aft of the funnel.



The mid-ship section of a 'Jiangwei 1' class frigate, showing the sextuple CSA-N-2 missile launcher at the left (van Ginderen) 0044943

Operational status

Development of the army version of the HQ-61 SAM system was completed in 1990 and the missile entered service in 1991. The naval CSA-N-2 (SD-1) version is installed on four 'Jiangwei 1' class frigates and is believed to have entered service in 1992.

Specifications

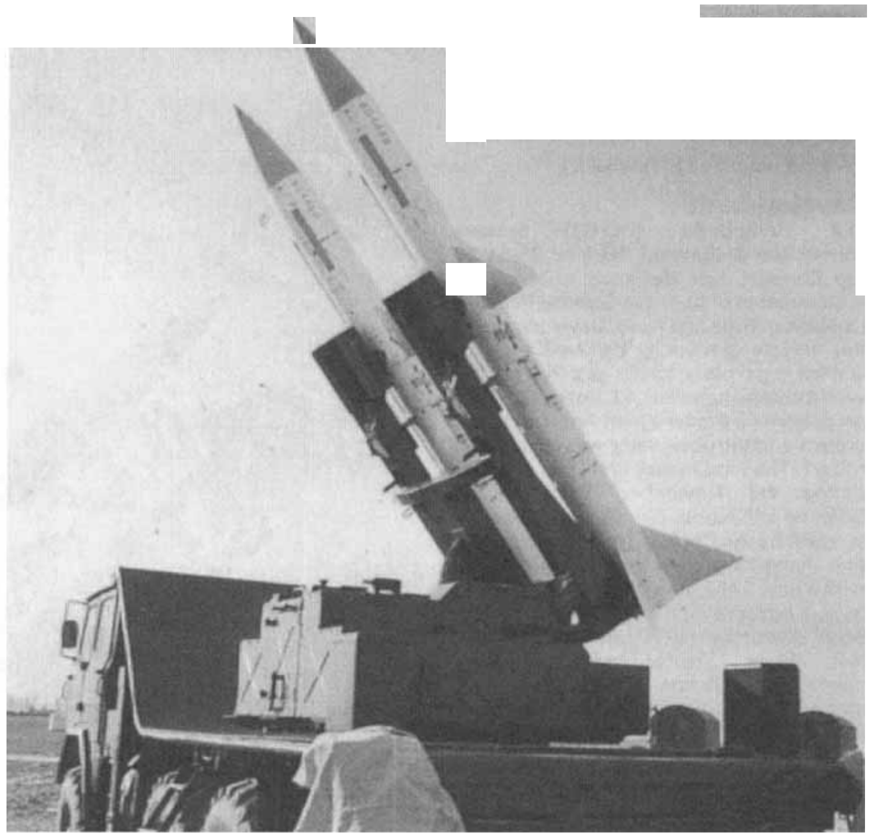
Length: 3.99 m
Body diameter: 0.29 m
Launch weight: 320 kg
Warhead: HE continuous rod
Guidance: Semi-active radar homing
Propulsion: Solid propellant
Range: 10 km

Associated radars
Surveillance radar: Model Type 571
Frequency: 1-2 GHz (L-band)
Peak power: 210 kW
Range: n/k
Surveillance radar: 'Knife Rest'
Frequency: 4-6 GHz (C-band)
Peak power: n/k
Range: n/k

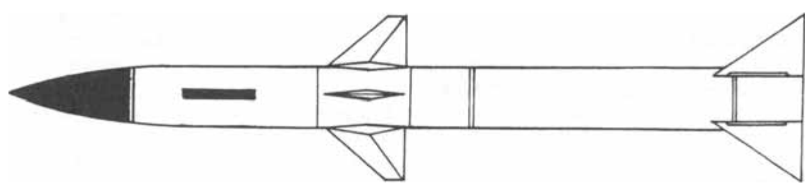
Engagement radars: 'Fog Lamp' or 'Rice Lamp'
Frequency: 8 - 12 GHz (X-band)
Peak power: n/k
Range: n/k

Contractor

Chinese State Factories; but marketed by China National Precision Machinery Import and Export Corporation (CPMIEC), Beijing.



A Chinese HQ-61 mobile surface-to-air missile, raised to the launch position on its self-propelled vehicle



A line diagram of the CSA-N-2 missile

CSA-4/-5, HQ-7, FM-80/-90

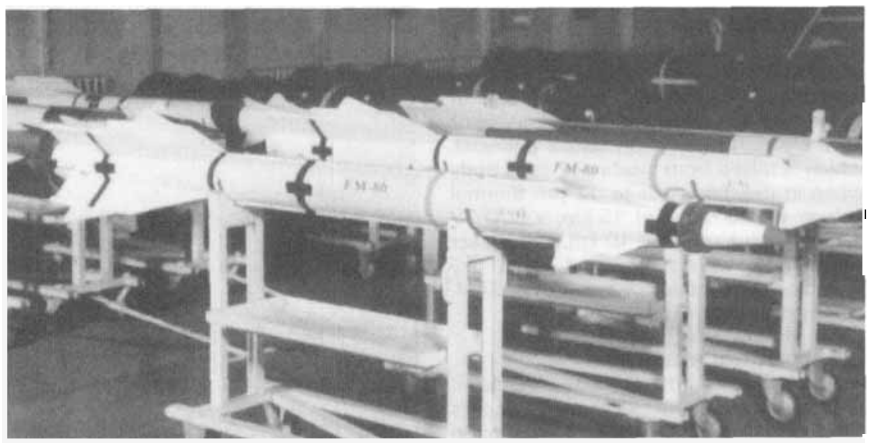
Type
Short-range, ground- and ship-based, solid propellant, theatre defence missiles.

Development
The FM-80 was first revealed at the 1989 Dubai Aerospace show, and FM-80 is the Chinese export designator. The missile system is believed to have been in development since 1978, and is similar to the French Crotale system. FM-80 has been designed as a self-propelled vehicle for a static or trailer-mounted point defence SAM system, and is believed to have the Chinese designator Hong-Qi-7 (HQ-7). The NATO designator is CSA-4, as the missiles were first used by the army in China, although these missile systems are also fitted to Chinese Navy ships. The HQ-7 system has been adapted for fitment to Chinese Navy destroyers, with an octuple launcher fitted to the 'Luhai', 'Luhu' (type 052) and 'Luda' (type 051) class destroyers. In 1998, the Chinese exhibited an improved version, believed to have the NATO designator CSA-5 and Chinese export designator FM-90, with an improved performance and a capability against smaller missile and UAV targets. An unconfirmed report suggests that later ships will have a vertical launch capability for CSA-4/-5 missiles.

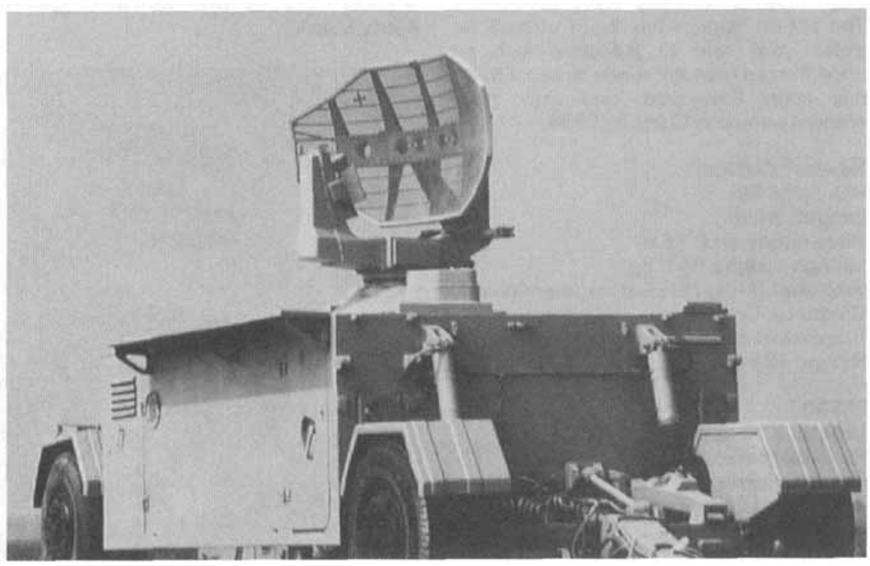
Description
Initial reports suggested that HQ-7 (CSA-4, FM-80) appeared to be a reverse-engineered version of the earlier French R440 Crotale missile system. HQ-7 is cylindrical in shape, with four small clipped delta canard control wings at the nose and four long chord fixed in-line heavily clipped delta fins at the rear. The missile has a length of 2.9 m, a body diameter of 0.15 m and weighs 84.5 kg. HQ-7 is command-guided, with surveillance and engagement radars supported by a TV tracker for use in severe ECM conditions. A combined TV and radar tracking mode is reported. The missile has a maximum velocity of 750 m/s (M2.2). The effective missile range is from 500 m to 12 km, between the altitude limits of 15 to 5,500 m. An operational fire unit consists of one surveillance radar vehicle (search system) and three launchers. The HQ-7 system has been shown with four missile canisters mounted on a four-wheeled launch platform, together with the engagement radar, TV tracker, the radio-command link and missile tracker. In 1996, the system was shown mounted on a wheeled vehicle, with three missile canisters. The radio-command link operates at 8 to 12 GHz (X-band) and the missile tracker is Infra-Red (IR).

The surveillance radar is a pulse-Doppler system operating at 2 to 4 GHz (S-band) mounted on the roof of a trailer-mounted shelter. This radar has an acquisition range of 20 km, and can process 30 targets, track 12 simultaneously, and designate three priority targets to the launchers. IFF is included. The engagement radar is mounted on the launch vehicle and is a monopulse 10 to 12 GHz (X-band) system,

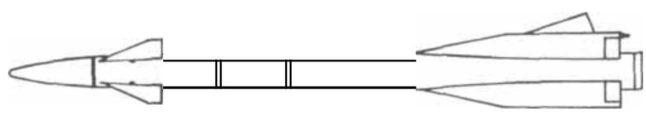
A model FM-80 launch vehicle with three missile canisters. displayed at Farnborough in 1996 (Peter Humphris)



HQ-7 missiles on production stands (CPMIEC) 0044946



An FM-80 surveillance radar vehicle. exhibited in 1994



*A diagram of **the** HQ-7 (FM-80) missile*

using frequency agility and diversity, and with a range of about 15 km. The radar elevation can cover –5 to +70°. The TV target tracker has a 3" field of view and a clear weather range of 15 km. For ship use, the surveillance radars can be 'Rice Shield' (S-band), Type 363 (C-band), Hai-Ying (C-band). TSR 3004 (S-band), 'Bean Sticks' (S-band). or 'Rice Screen' (C-band). The engagement radar on ships is the Castor 2, an X-band system.

The improved FM-90 version is believed to use a missile similar to the Shahine R460 from the French Crotale system, which has a length of 3.12 m, a body diameter of 0.16 m, and a launch weight of 100 kg. The missile has a 15 kg HE warhead and a maximum range increased to 15 km. The minimum range is 700 m, and targets can be engaged at altitudes from 15 m to 6 km. The FM-90 missile has a maximum speed of 900 m/s (M 2.65). The surveillance radar has an acquisition range increased to 25 km, and the engagement radar has an acquisition range of 20 km. In 1999, NORINCO exhibited a Sky Shield air defence passive fire-control system, mounted on a 6 X 6 wheeled truck. It is believed that the Sky Shield can be used with the HQ-7 (FM-80) and FM-90 missile systems, and that it provides a completely passive set of sensors for use when anti-radar missiles or ECM are being used. The sensor pedestal, which is raised from inside the truck body when in use, has an 8 to 12 µm thermal imager with a range of 15 km, a CCD TV camera with a range of 10 km, and a laser range-finder with a range of 8 km. Sky Shield can be used to control AAA or SAM, **or** a mixture of both

Operational status

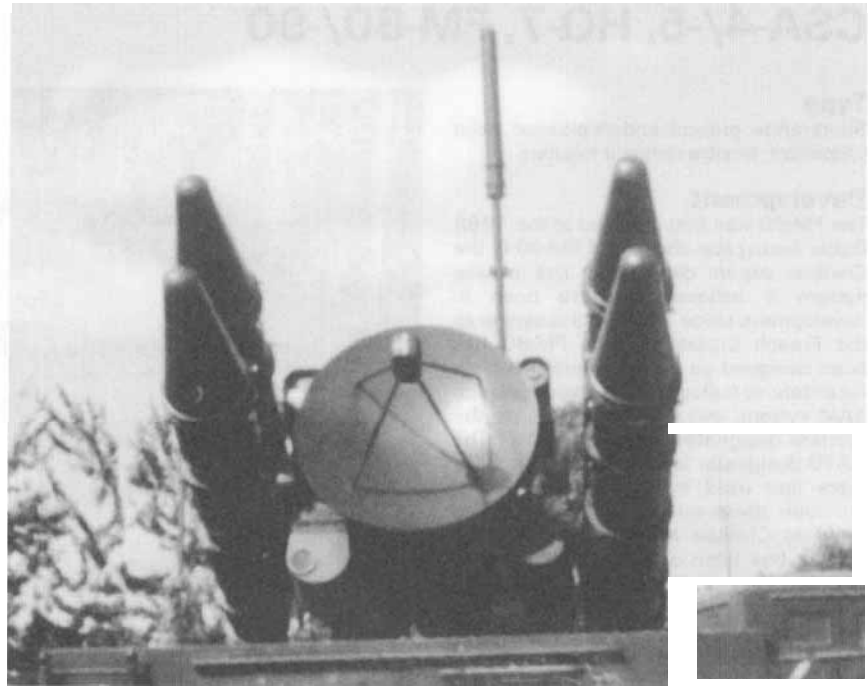
HQ-7 is believed to have entered production for the Chinese People's Liberation Army in 1989, and entered service in 1991. The naval version has been fitted to Chinese Navy destroyers. The FM-80 system has been offered for export and sold to Pakistan, with an unconfirmed report of a sale to Iran. FM-90 has been developed, and may have entered service in China in 1998.

Specifications

HQ-7 **(FM-80)**
Length: 2.9 m
Body diameter: 0.15 m
Launch weight: 84.5 kg
Warhead: 14 kg HE blast fragmentation
Guidance: Command
Propulsion: Solid propellant
Range: 12 km

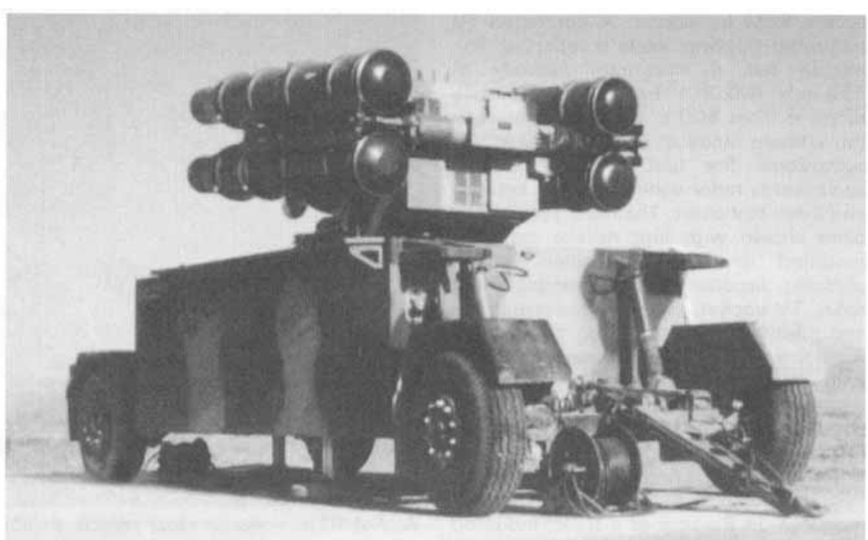
FM-90
Length: 3.12 m
Body diameter: 0.16 m
Launch weight: 100 kg
Warhead: 15 kg HE
Guidance: Command
Propulsion: Solid propellant
Range: 15 km

Associated radars
Surveillance Radar
Frequency: 2-4 GHz (S-band) pulse-Doppler
Peak power: n/k
Range: 20 km (HQ-7). 25 km (FM-90)



An FM-90 launcher showing the engagement radar antenna and EO tracker (CPMIEC) 0044947

A 'Luhai' class destroyer, with an octuple HQ-7 launcher forward of the bridge (Harry Steele) 2002/0120632



An FM-80 (HQ-7) missile launcher trailer (CPMIEC) 0044945

Engagement radar
Frequency: 10-12 GHz (X-band)
Peak power: n/k
Range: 15 km (HQ-7). 20 km (FM-90)

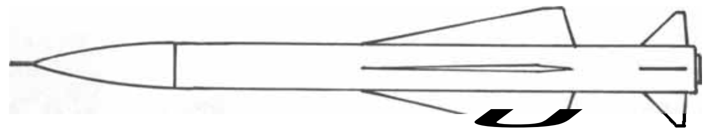
Contractor

Chinese State Factories; but marketed by China National Precision Machinery Import and Export Corporation (CPMIEC), Beijing.

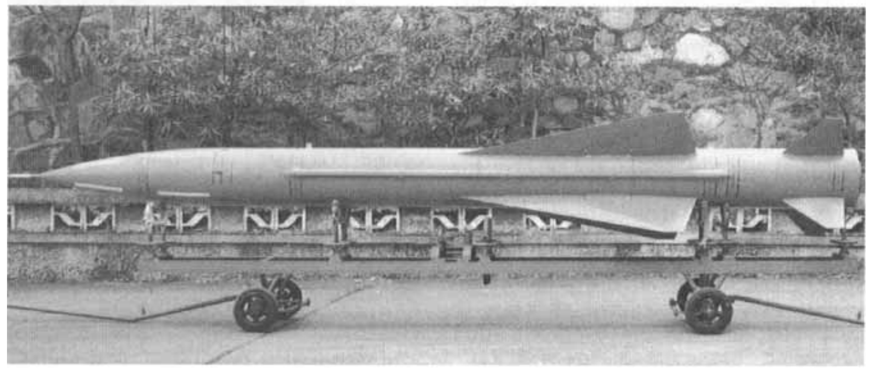
KS-1/FT-21 00

Type
Short-range, ground-based, solid propellant, theatre defence missile

Development
China's KS-1 surface-to-air missile was first revealed at the 1991 Paris Air Show and little is known of its development. The missile is similar in size and weight to the US MIM-104 Patriot, but has a quite different shape. The KS-1 is designed to engage aircraft, helicopters and UAVs, and according to China National Precision Machinery Import and Export Corporation (CPMIEC) it can also engage air-to-surface missiles. The missile works in conjunction with a phased-array radar. The export designator used in 1999 was FT-2100. In 2000 an upgraded KS-1A version was offered for export, with increased range and an improved phased array radar.



A line drawing of the Chinese KS-I medium-range SAM



Chinese KS-1 surface-to-air missile (CPMIEC)

Description
The KS-1 SAM is similar in appearance to the UK Rapier surface-to-air missile, but a great deal larger. The missile has a cylindrical body with a sharp pointed nose, cruciform delta-wings rear of mid-body with in-line clipped delta tail control fins. The KS-I is 5.6 m long, has a body diameter of 0.4 m and weighs 900 kg at launch. The missile is command guided throughout flight. The solid propellant motor gives the missile a maximum velocity of 1,200 m/s (M4.0) and a maximum slant range of 40 km. The minimum intercept range is 7 km. Details of the warhead and fuzing are not known, but are believed to be HE blast/ fragmentation with an RF fuze. The KS-1 system is capable of engaging targets at altitudes from 500 m to 25 km.

A typical KS-1 battery would consist of a phased-array radar guidance station, four twin-missile launch vehicles on a 6 × 6 truck chassis and associated support vehicles. Including the eight missiles in the ready to launch position, the battery would have a total of 24 missiles. No technical details of the phased-array engagement radar have been given, although CPMIEC says it has an all-weather, multi-target tracking, ECM and 360" capability. The KS-1 system probably uses a target surveillance radar at battery or battalion level, and it is believed that this radar has the designator SJ-202 and is similar to the 'Gin Sling A radar used with the HQ-2 system. It is believed that there is also a shelter-mounted system in service in China.

The KS-1A version has an increased range of 50 km, and a maximum intercept altitude of 27 km The improved phased array radar is mounted on a 6 × 6 wheeled trailer, and a model displayed an antenna similar to the US Patriot AN/MPQ-53 and Russian SA-10 'Grumble' (S-300 PMU) 'Flap-Lid B' (30N6) surveillance/ engagement radars. This radar can engage three targets at the same time, and is believed to be based upon technologies derived from the SA-IO radar with a range of 100 km and operating in S-band.

Operational status
The KS-1 missile system is believed to have entered service in China in 1996. The purchase by China of Russian SA-IO 'Grumble' (S-300) missiles and technologies may result in only a limited number of KS-1 missiles entering service. The improved KS-1A missile system was offered for export in July 2000, but there are no known sales It is believed that the KS-1A missile is not yet in service in China.

Specifications
Length: 5 6 m
Body diameter: 0.4 m
Launch weight: 900 kg
Warhead: HE blast/fragmentation
Guidance: Command
Propulsion: Solid propellant
Range: 40 km (KS-I), 50 km (KS-1A)

Associated radars
Surveillance: SJ-202
Frequency: n/k
Peak power: n/k
Range: 115 km
Engagement: Phased-array
Frequency: 2 -3 GHz (S-band)
Peak power: n/k
Range: 45 km (KS-I), 100 km (KS-1A)

Contractor
Chinese State Factories; but marketed by China National Precision Machinery Import and Export Corporation (CPMIEC), Beijing

LY-60

Type
Short-range, ground- and ship-based, solid propellant, theatre defence missile.

Development
The LY-60 (Hunting Eagle) surface-to-air missile was first exhibited by China at the 1995 Paris Air Show. The missile is similar in size, shape and performance to the US RIM-7 Sea Sparrow and Italian Aspide (Albatros/Spada). An air-to-air missile variant was displayed as a model under the Chinese FC-1 fighter aircraft, and is believed to have the Chinese designator PL-11. The first development of LY-60 is believed to have been for the Chinese Army with mobile wheeled trucks carrying the radars and missiles. Three 'Jiangwei 2' frigates have been fitted with the LY-60 system, and it is reported that the LY-60 system may also be fitted to 'Luda 3' destroyers. An unconfirmed report in 2001 suggested that some 'Jiangwei 1' class frigates might be modified to carry LY-60 missiles in place of their present CSA-N-2 (SD-1) missiles.

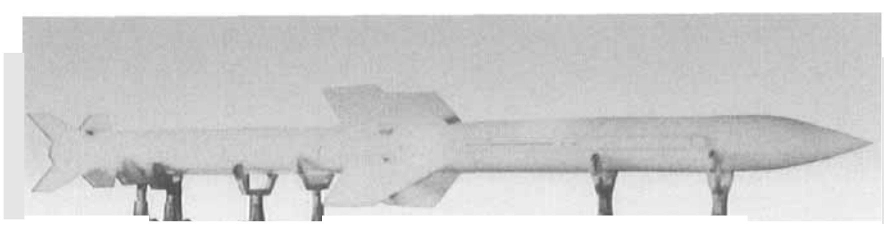
A report in 1996 stated that an improved version is now in development, with an increased range.

Description
LY-60 is similar in size and shape to the RIM-7 Sea Sparrow. The wings and fins are similar in shape to the Aspide missile. The missile is 3.89 m long, has a forward body diameter of 0.203 m, an aft body diameter of 0.21 m, a wing span of 0.68 m and a launch weight of 220 kg. A solid propellant boost and sustainer motor accelerates the missile to a speed of M3.0, with a minimum intercept range of 1 km and a maximum range of 18 km. LY-60 can engage targets down to 30 m and up to 12 km altitude. Guidance is by a continuous wave 8 to 12 GHz (X-band) semi-active radar seeker with a home-on-jam capability. The missile rear fins are fixed, with control provided by four moving wings mounted at the centrebody. The moving control wings are folded when the missile is in a canister. The warhead is described as prefabricated fragmentation, using steel balls, with a weight of 33 kg.

The LY-60 ground-based system consists of a surveillance radar vehicle, an engagement radar vehicle, and a launcher vehicle with five missile canisters that are raised for launching. A typical fire unit has one surveillance radar, three engagement radars, six missile launch vehicles and an emergency power supply vehicle. In addition. there are missile reloading vehicles and several maintenance vehicle; The surveillance radar is capable of processing 40 targets, and of tracking 12. The LY-60 engagement radar can only carry out one engagement at a time with the semi-active radar homing missiles On the ships, the surveillance radars are 'Knife Rest' (C-band) or 'Rice Screen' (3-D C-band), and the engagement radars are Type 343 'Sun Visor' (X-band) or 'Fog Lamp' (X-band).

The surveillance radar vehicle of the LY-60 missile system 2001 0100712

A model of a LY-60 launch vehicle, with five missile canisters raised to the launch position (Duncan Lennox) **2001**/0100713



An LY-60 surface-to-air missile first displayed in 1995 at the Paris Air Show

Operational status

It is believed that the LY-60 system entered service with the Army in China in 1996 and with the Navy in 1999. Three 'Tariq' (Amazon) class type 21 frigates, in service with the Pakistan Navy, have been fitted with LY-60N missile launchers, with one sextuple launcher mounted forward of the bridge.

Specifications

Length: 3.89 m
Body diameter: 0.21 m
Launch weight: 220 kg
Warhead: HE fragmentation 33 kg
Guidance: Semi-active radar
Propulsion: Solid propellant
Range: 18 km

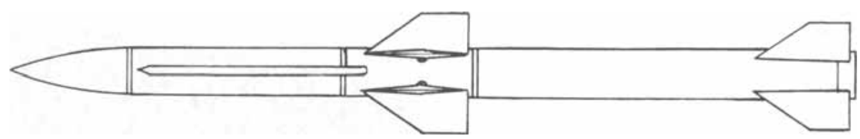
Associated radars
Surveillance radar: 'Rice Screen' or 'Knife Rest'
Frequency: 4 - 6 GHz (C-band)
Peak power: n/k
Range: n/k

Engagement radar: 'Fog Lamp' or type 343 'Sun Visor'
Frequency: 8 - 12 GHz (X-band)
Peak power: n/k
Range: n/k

Contractor

Chinese State Factories; but marketed by China National Precision Machinery Import and Export Corporation (CPMIEC), Beijing. It is believed that the missile was developed by the Shanghai Academy of

The engagement radar vehicle of the LY-60 system



A line diagram of the Chinese LY-60 missile

HQ-I 5, FT-2000

Type

Short- and medium-range, ground-based, solid propellant, theatre defence missiles

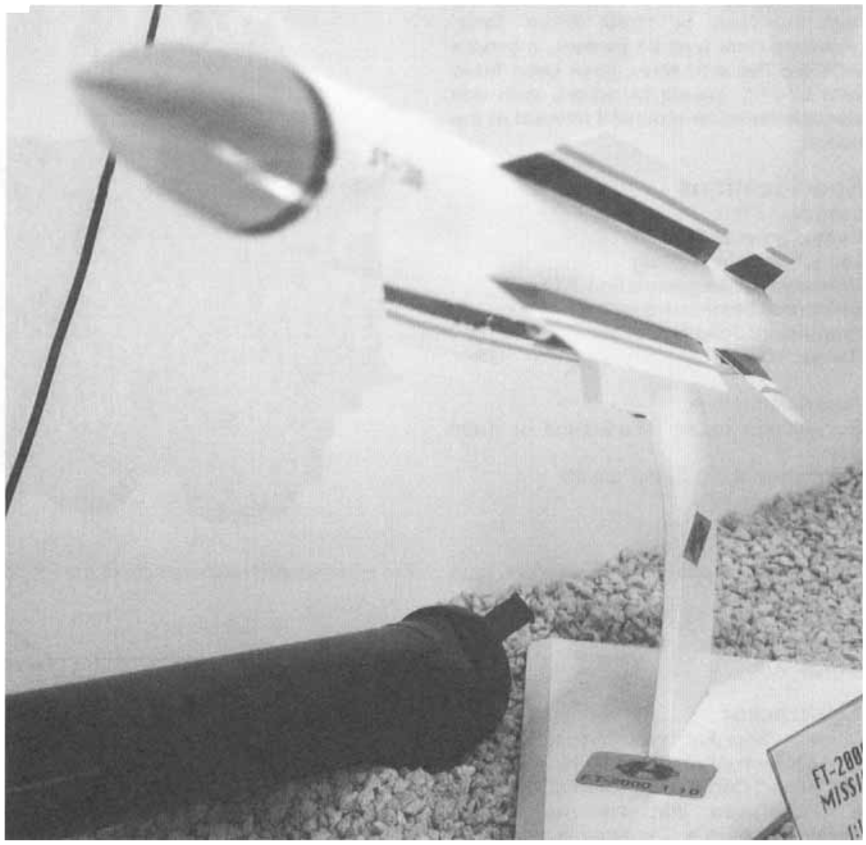
Development

The Chinese have developed a surface-to-air missile system specifically for use against airborne early warning, command and control, and ECM aircraft From the shape and size of the missile, it appears to be an amalgamation of Russian SA-I 1 'Gadfly', SA-I7 'Grizzly' and SA-IO 'Grumble' missiles The SA-IO has been manufactured under licence in China as the HQ-10, and it is possible that the new missile ıs an upgraded SA-IO design The missile is believed to have the Chinese designator Hong-Qi-15 (HQ-15). and in its exoort form has the Chinese designator FT-2000. A first test launch was reported in September 1997. A second missile, with the export designator FT-2000A has also been reported. This version has been made to be compatible with the HQ-2 missile system, although it still requires separate launchers and fire-control units. In late 1999, a third missile type was offered for export by the Chinese, this was a land-attack cruise missile with the designator Chang-Feng-2000 (CF-2000). This missile is similar to that used in the FT-2000 system, but has two strap-on solid propellant boost motors added to give a maximum range of 150 km. A report in August 2001 stated that a semi-active/active radar-guided version was in development, using an improved dual-mode surveillance and engagement radar based upon the 30N6 radar used with SA-I0 'Grumble'.

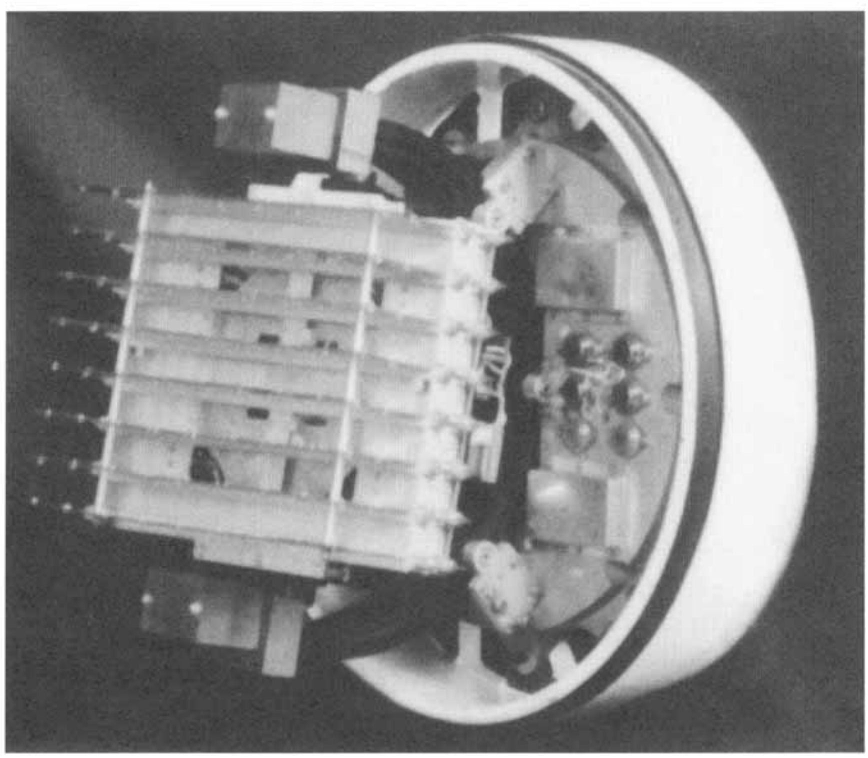
Description

The HQ-15 missile has a length of 6.8 m, a body diameter of 0.47 m, and a launch weight of 1,300 kg. There are four short chord wings at mid-body, similar to those on the Russian SA-I 1 'Gadfly' and SA-I7 'Grizzly', with four clipped-tip moving delta fins at the rear. The missile looks to be similar to the 5V55 version used in the Russian SA-IO 'Grumble' system, with wings added to give a longer range. Control is by the rear fins and a thrust vector control system with four moving vanes in the exhaust nozzle. It is believed that the warhead weight is 130 kg HE. Guidance is inertial with a broadband passive radar seeker covering the 2 to 18 GHz frequency range. The passive seeker has a memory, for use if the target radar is switched off, and a home-on-jam capability. The missile has a solid-propellant motor, with a minimum range of 12 km and a maximum range of 100 km. Targets can be intercepted at altitudes between 3 and 20 km.

The mobile transporter-erector-launcher vehicle is an 8 × 8 wheeled vehicle, similar to the Russian 5P85S vehicle used with the SA-IO 'Grumble', with four missile



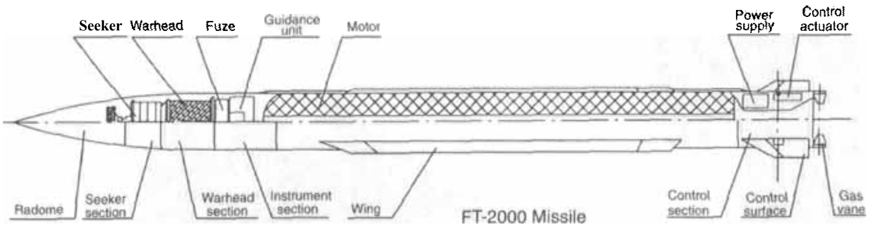
A model of the HQ-75 (FT-2000) missile displayed at Farnborough in 1998 (Duncan Lennox) 0044949



A passive radar seeker assembly for the HQ- 15 missile (CPMIEC) 0044950

canisters that are raised to the vertical for launching. This vehicle has a loaded weight of around 42,000 kg, and there are four hydraulic stabilising jacks for use when the missiles are to be launched. A surveillance radar and passive ESM receivers are associated with the HQ-15 system, but no details have been released.

The second version, known as FT-2000A in its export version, is reported to have a passive radar seeker covering the 2 to 6 GHz (S and C-band) range, that has its frequency selected on the ground before launch. This missile has a maximum range of 60 km, and can be used as part of the HQ-2 system. However, it is stated that the missile requires separate launchers and fire-control units. One report also suggests that the FT-2000A is a totally different missile to the FT-2000, being based upon the HQ-2 missile design.



A diagram of the HQ-15 (FT-2000) missile 0044951

An HQ-15 transporter-erector-launcher vehicle (CPMIEC) 0044948

Operational status

The first flight test of the HQ-15 (FT-2000) missile is reported to have been made in September 1997, and it is believed that the missile entered service in China in 1998. A report in July 2000 suggested that the missile was still in development, and would not enter service until 2005, but it is believed that this report referred to the semi-active/active radar-guided version.

Specifications

Length: **6.8** m
Body diameter: 0.47 m
Launch weight: 1,300 kg HE
Warhead: 130 kg HE
Guidance: Inertial with passive radar
Propulsion: Solid propellant
Range: 100 km

Associated radars
Surveillance radar: n/k
Peak power: n/k
Range: n/k

Contractor

Chinese State Factories; but marketed by China National Precision Machinery Import and Export Corporation (CPMIEC), Beijing.

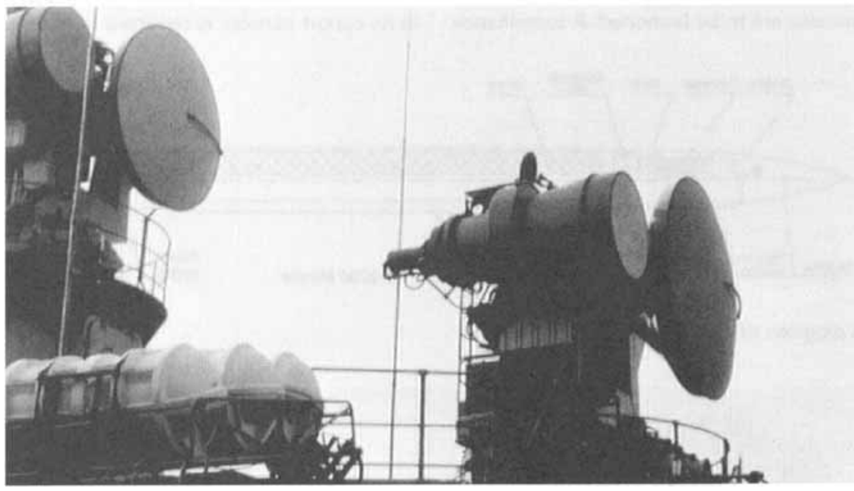
Masurca

Type

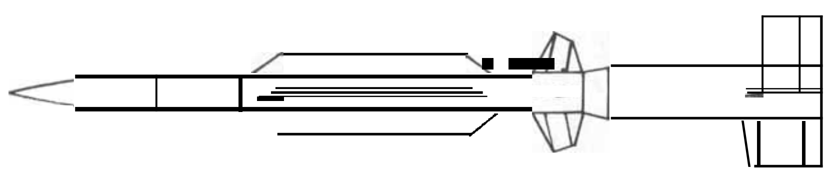
Short-range, ship-based, solid propellant, theatre defence missile.

Development

Masurca *(Marine Supersonique Ruelle Contre Avions)* was developed by the French DCN *(Direction des Constructions Navales)* ECAN Ruelle in the mid-1960s to equip medium-size warships of the French Navy. Although the dimensions are different, the design of the missile was clearly influenced by the American RIM-24 Tartar missile that the French Navy had purchased for their Type 47 class destroyers in the early 1960s. The launcher/handling system also resembles the US GMLS Mk 10 system. Two versions of the Masurca were developed: the Mk 2 Mod 2 using radio-command guidance and the Mk 2 Mod 3 with a semi-active radar homing head. The fire-control radar, missile homing head and proximity fuze were developed by Thomson-CSF (now Thales). Solid propellants were manufactured by SNPE and the launch and handling equipment were designed and developed by ECAN Ruelle. The first Masurca system entered service with the destroyer *Suffren* in July 1967. It was later fitted to the second 'Suffren' class destroyer, *Duquesne,* in 1970 and the cruiser *Colbert* in 1972. Each of the three ships carried a total of 48 missiles and was fitted with a three-dimensional surveillance radar, two engagement radars, two independent fire-control systems and a single twin launcher situated on the stern deck.



Masurca DRBI 51 engagement radar group on the Suffren *destroyer* (Stefan Terzibaschitsch)



A line diagram of a Masurca surface-to-air missile

Description

The Masurca missile, without its large booster, is similar in shape to the US RIM-24 Tartar and the later RIM-66/-67 Standard missiles. It is cylindrical in shape, has a pointed radome and four long chord, rectangular wings with a narrow span. These are situated aft of the missile's mid-point in a cruciform configuration, and there are four in-line, clipped and raked delta control fins at the rear. The missile, without booster, is 5.29 m long, has a body diameter of 0.4 m and weighs 950 kg. The tandem solid propellant booster is 3.31 m long, has four in-line, clipped delta stabilising fins, weighs 1,140 kg and separates from the missile after 5 seconds burning time when the missile is travelling at around M3.0.

The missile's warhead is a 98 kg HE continuous rod type, which is activated by a Thales radio-frequency proximity fuze. Originally there were two types of guidance used. The Masurca Mk 2 Mod 2 (no longer in service) followed a 'line of sight' trajectory, and was radio-command guided by the engagement tracking radar. The Masurca Mk 2 Mod 3 is equipped with a Thomson-CSF (now Thales) X-band (8 to 12 GHz) semi-active radar seeker, and follows a proportional navigation trajectory. The missile is fitted with two antenna systems: the seeker radar dish behind the ceramic radome; and two rearward facing fixed antennas mounted on the missile body to receive rear reference data from the engagement radar. The SNPE extruded double-based sustainer motor gives the missile a range of 55 km against high-level targets, but less against low-level targets.

The rest of the Masurca system consists of the launching and handling system, two Thomson-CSF (now Thales) DRBR 51 engagement radars, a weapon direction and fire-control system and a built-in test system. The launching/handling system includes a twin ramp launcher with 360" traverse. Each ramp is served by a horizontal reloading drum with 18 missiles. The reloading drums may also be replenished from the magazine, which can hold a further 12 missiles. The DRBR 51 engagement radar is a C-band (4 to 6 GHz) radar with three antennas and a TV camera for low-level tracking. The main C-band antenna tracks and illuminates the target and also tracks the missile. A second C-band antenna transmits the command signals to ensure the missile remains on the line of sight until the onboard seeker is activated. The third, broad beam antenna is

A Masurca twin lauiicher with missiles displayedat a French Naval Exhibition at Le Bourget in 1970

used to gather the missile after launch. Two missiles may be tracked by each director simultaneously.

During operations, the targets are initially detected by the ship's main radar, which in the case of the 'Suffren' class destroyers is the Thomson-CSF (now Thales) DRBI 23 L-band air/surface surveillance radar. The DRBI 23 is a three-dimensional long-range search radar with a transmitter peak power of 2 MW. Height information is obtained by the use of the stacked beam technique, this data being processed to provide corrected height information on aircraft targets.

Operational status

Masurca entered service with the French Navy in 1967. Only the Mk 2 Mod 3 version is left in service with the two 'Suffren' class destroyers, with one of the ships in reserve. Masurca missiles and ship systems were updated in the mid-1980s. There are no known exports.

Specifications

Mk 2 Mod 3

Length: 8.6 m (5.29 m without booster)
Body diameter: 0.4 m
Launch weight: 2,090 kg (950 kg without booster)
Warhead: 98 kg HE continuous rod
Guidance: Command and semi-active radar
Propulsion: 2-stage solid propellant
Range: 55 km

Associated radars
Surveillance radar: DRBI 23
Frequency: 1-2 GHz (L-band)
Peak power: 2 MW
Range: 200 km
Engagement radar: DRBI 51
Frequency: 4-6 GHz (C-band)
Peak power: n/k
Range: 75 km

Contractors

Direction des Constructions Navales, Paris (system).
MBDA Missile Systems, Paris (missiles).
Thales, Bagneux (radars).

Crotale/Shahine/R440, R460, VT-1

Type

Short-range, ground- or ship-based, solid propellant, theatre defence missiles.

Development

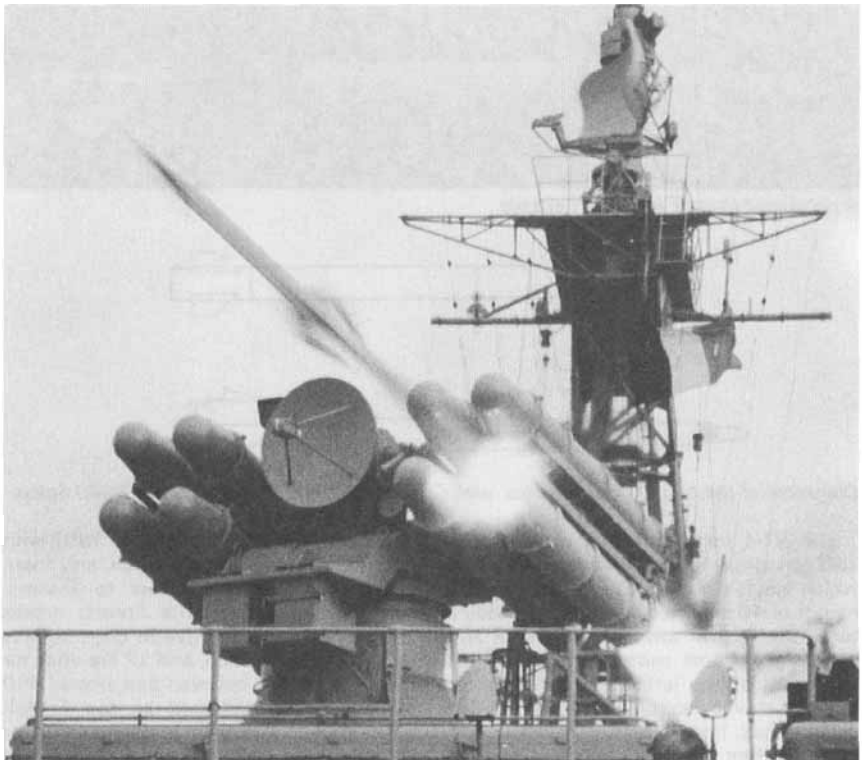
Design of the Crotale began in 1964, when a South African order for the Bloodhound SAM was refused by the UK government. With the South African government contributing 85 per cent of funding and the French government providing the other 15 per cent, Thomson-CSF (now Thales) was selected as prime contractor for the system, which was known as Cactus to the South Africans. The first firing of an unguided missile took place in 1965, with the first guided firing taking place in 1967. The first Cactus system was delivered to South Africa in May 1971 and was declared operational in August that year. In 1971, Crotale was selected by the French Air Force for evaluation and, in 1972, development of a naval version was started. In 1974-75, development commenced on another export model called Shahine. This was totally funded by Saudi Arabia, and had a number of improvements over the basic Crotale (many of which have been incorporated into later systems). Delivery of the first Shahine system to Saudi Arabia took place in 1980. The Saudis also ordered the standard Crotale system in 1978 for the air force. In July 1977, the first French Air Force Crotale squadron was formed and was declared operational in December of that year. The first test firings of the naval version took place in 1977 and the system became operational with the French Navy in March 1980. From 1982, improved variants of both land- and sea-based weapon systems were introduced, including Modular and Compact Crotale Naval and Crotale S. Due to limitations in the TV system, in 1980 Saudi Arabia requested a point defence system with an all-weather, day and night anti-sea-skimmer capability. This resulted in a new passive IR tracking system designed by SAT and called SEID (systeme decartometrie infra-rouge *differen*tiel: infra-red differential tracking system) being fitted to Crotale Naval. Test firings of this system, known as Crotale Naval EDIR *(ecartometrie* differentiel infra-rouge), took place in 1984. SEID can be retrofitted to existing Crotale Naval systems to bring them up to EDIR standard. Crotale Naval is fitted to 'Clemenceau' class aircraft carriers, (two octuple launchers), to 'George Leygues' and 'Tourville' class destroyers (one octuple launcher), and to 'La Fayette' class frigates, (one octuple launcher). Crotale Naval EDIR is also in use on board Saudi Arabian 'Madina' class frigates, and 'Muray JIB' class corvettes with the United Arab Emirates. The first system, produced in 1969, was called the 1000 series. This was followed by the 2000 series in 1973, the 3000 series in 1975, the 4000 series in 1983 and the 5000 series in 1985.

A new programme called Crotale NG (New Generation) was launched in 1985. It was initially called Liberty, and Thomson-CSF (now Thales) offered it to the USA in the FAADS-LOS-L-H competition that was eventually won by Oerlikon's ADATS. The Crotale NG system uses a new missile, designated VT-1, and the first 1,000 missiles were built in the USA by LTV (now Lockheed Martin) at Dallas in Texas. These missiles were delivered between 1991 and 1992, and Thales planned to transfer further production to France, but did not do so. In 1990, the French Navy selected the Crotale NG (known as CN2) for the 'La Fayette' class frigates, and this system entered service in 1992.

A Shahine launcher vehicle with *six* missile canisters and engagement radar (Thomson-CSF) 0008600

A Finnish Army wheeled armoured vehicle, carrying a Crotale *NG* missile system (Thomson-CSF) 0008599

In 1988, at the second ASIANDEX exhibition in Beijing, the China National Precision Machinery Import and Export Corporation (CPMIEC) revealed their HQ-7 (FM-80) land-mobile surface-to-air missile system, which is similar in most respects and might well be a reverse-engineered version of the earlier Crotale R440 design. In 1996, South Korea revealed details of the Chun-Ma (Pegasus) SAM system, which uses the sensor suite from Crotale NG but with a different missile. In 1999, reports from Iran stated that Project Ya-zahra had successfully reverse engineered



The launch of a Naval Crotale from an octuple lauiicher

Crotale R440 missiles captured from Iraq during the 1980 to 1988 war. However, as Iran has also bought FM-80 missiles from China, it is possible that the technology for manufacture was transferred at the same time.

In 1996, a study was completed between Thomson-CSF (now Thales) and the Russian company Fakel MKB to adapt Crotale NG (VT-1) missiles for vertical launch. Flight trials were made in Russia starting in 1997, and the development has been completed. Fakel have designed vertical launch systems for both land and sea-based systems including SA-IO, SA-15, SA-N-6 and SA-N-9. In 2000, a proposal was made to use Crotale NG together with short-range surface-to-air missiles in a Flexible Modular Air Defence (FMAD) system, with the short-range missiles being Mistral, Stinger, Igla, Starburst or Starsteak. In February 2001, Thales finally decided to develop and build a new version of the VT-1 missile, with production at Thales Air Defence (formerly Shorts Missile Systems) in Belfast, Northern Ireland.

Description

The Crotale missile, designated R440, has four small clipped delta canard control-wings at the nose and, at the rear, four long chord, fixed in-line heavily clipped delta fins with ailerons for roll control. The tips of these rear fins are retractable and extend once the missile clears the launch tube. A transponder to assist radar tracking and a guidance command receiver antenna are fitted to two of the rear fins. On the later EDIR variants there is also an infra-red tracking flare on the rear of the fuselage. The missile is 2.89 m long, has a body diameter of 0.15 m and weighs 85 kg at launch. The HE directed burst/ fragmentation warhead weighs 14 kg, has a lethal radius of 8 m and is activated by an infra-red fuze or contact fuze (later models have an RF Doppler fuze). The missile is fired from the launch tube by a solid propellant, single-stage motor that accelerates it to the maximum speed of M2.3 in 2.5 seconds. Effective range of the system is between 500 m and 10 km at altitudes of 15 to 4,000 m. A typical land-based Crotale system consists of up to three fire units, each with four missiles, linked to an acquisition unit. The fire unit for a land-based system carries a rotating turret, with four Crotale missiles in two pairs on either side of the X-band monopulse engagement radar for target and missile tracking. The basic naval unit comprises an eight-round turret assembly, with an underdeck magazine holding 16 reloads. In the Crotale Naval system, the acquisition radar is replaced by the ship's own surveillance radar. Immediately after launch, the missile is gathered by an infra-red tracker with a 5" field of view, and steered into the engagement radar's line of sight. The fin-mounted transponder is picked up by the radar and the angular error between the target and missile is measured by the fire-control computer, which issues steering commands via an 8 to 10 GHz (X-band) digital datalink to the missile's autopilot. The commands are then translated into movement of the canard fins. The engagement radar is capable of tracking two missiles and guiding them towards a single target, thus allowing salvos to be fired. In early models, a TV camera was fitted to the turret to track the missile in engagements at extremely low level, or in heavy ECM conditions. Because TV tracking is only possible in daylight and good weather conditions, the basic version of Crotale Naval could not engage sea-skimmer targets at night or in adverse weather conditions. Therefore, later versions had the TV camera replaced by SEID. This employs a thermal imager, operating at 8 to 12 µm wavelength, to track both the incoming target and outgoing missile. SEID has a range of more than 20 km, sufficient to begin tracking in good time before engaging the target at the missile's maximum range, which is about 8.5 km at low altitude. Another major improvement in this later missile is the replacement of the IR proximity fuze with an RF Doppler fuze, which is reported to detect objects flying only a few metres above the water. Modular Crotale Naval consists of a trunnion mounting containing eight missile canisters, and a separate fire director unit mounting the radar, TV and SEID IR trackers.

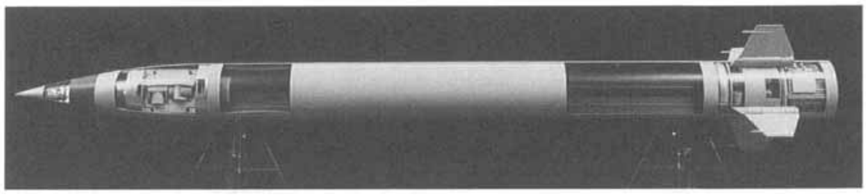
The Shahine missile is designated R460, and although it looks similar to the R440, it is longer, heavier and has an uprated motor for increased performance and range. The missile is 3.12 m long, has a body diameter of 0.16 m and weighs 100 kg at launch. The HE focused splinter warhead weighs

A Crotale NG container system. exhibited at Paris in 1997 The rectangular surveillance radar is above the parabolic engagement radar antenna, with a TV camera and IR radiometer mounted on the right side of the engagement radar dish, and a FLIR on the left (Duncan Lennox)
0008598

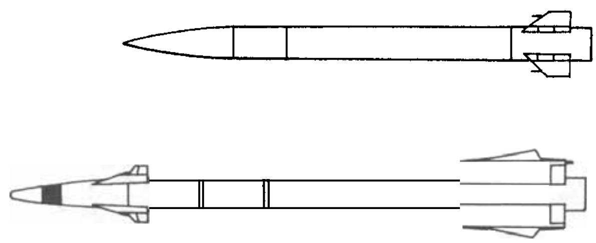
15 kg, has a lethal radius of 8 m and is activated by an infra-red proximity fuze (the fuze is activated 350 m before interception), or a contact fuze. The missile is launched from its tube by a solid propellant dual-thrust motor; the boost phase burns for 1.75 seconds and the sustain phase for 2.3 seconds. The Bastien motor uses a cast double-base propellant made by Bayern-Chemie, with 16.1 kg of propellant used for the boost phase and 19.0kg for the sustain phase. The motor accelerates the missile to M2.8 (maximum speed). The maximum effective range of the system is between 0.5 and 11.5 km (15 km against helicopters), at altitudes from 15 to 6,800 m. The mobile fire unit, based on an AMX-30 MBT chassis, carries a rotating turret with six R460 missiles in two pairs of three on either side of the X-band monopulse engagement radar for target and missile tracking. A second AMX-30 MBT carries the surveillance radar. The launch/guidance procedures and techniques are the same as for basic Crotale.

The Shahine 2 is an upgraded system that increases the range of the engagement radar out to 19 km and gives the option of an electromagnetic fuze on the missile warhead to replace the IR fuze circuitry. There is also a towed shelter version of Shahine 2.

The Crotale NG system uses a new missile, VT-1, developed by LTV Missiles and Electronics (now Lockheed Martin Missiles and Fire Control Systems) The VT-1 missile is smaller than the R440; it has no forward fins and the rear control fins fold, thus allowing a smaller launch tube. The missile is 2.29 m long, has a diameter of 0.17 m and a launch weight of 73 kg. The 14 kg HE focused blast fragmentation warhead has an electromagnetic proximity fuze. A single operator can control the complete system, which is mounted on a single vehicle. Several vehicles, both tracked and wheeled, have been adapted as the TELAR for Crotale NG. A transportable shelter (containerised) system is also available. For ship use there are three launchers available; a compact six canister, a lightweight eight missile launcher, and a newly developed vertical launch system. The Crotale NG system consists of a frequency-agile pulse-Doppler 2 to 3 GHz (S-band) surveillance radar which can track up to eight separate targets with a range of 30 km and coverage up to 5 km altitude. The engagement radar is a frequency-agile pulse-Doppler 35 GHz (K-band) system using TV and IR combined target trackers, with the missile being tracked by a separate IR sensor. The engagement radar has a range of 20 km, the TV camera (CCD) a range of 15 km, and the FLIR a range of 20 km. The solid propellant motor gives the missile a maximum speed in excess of M3.5. This flies the missile out to 8 km in 10 seconds, with a minimum range of 500 m and a maximum range against aircraft targets of 11 km, or 6 km against sea-skimming missiles. The missile has a maximum flight time of 18 seconds. The VF-1 missile can engage targets flying at altitudes between 5 and 6,000 m.



A sectioned Crotale NG (VT-1) missile



*Diagrams of the two Crotale missiles. with Crotale NG (VT-1) above and the **R440** below*

The VT-1 vertical launch system uses cold gas ejection from a modified canister, which ejects the missile at 40 m/s up to a height of 40 m, when a pitch-over module turns the missile towards the target and ignites the boost motor. The pitch-over assembly is then jettisoned well clear of the launcher or ship. The vertical launch system has been called 'Quadrax', and includes four missile canisters grouped together. A double group of eight missiles has a weight of just under 2,000 kg, which is considerably less than the conventional above deck launchers on ships, and the cold launch technique greatly reduces corrosion damage to the launch systems.

Operational status

Crotale first entered service in 1971 in South Africa, where it is known as Cactus-Crotale; the Shahine version entered service in Saudi Arabia in 1980 and Crotale Naval entered service with the French Navy in 1980. The missiles are still in service, with over 6,400 ordered for land and naval use. Crotale Naval is used by France, Saudi Arabia and United Arab Emirates, and two systems were reportedly sold to China in 1987 for delivery in 1989. Countries using the land-based system are: Bahrain; China; Egypt; France; Libya; Pakistan; Saudi Arabia; South Africa and United Arab Emirates.

Crotale NG entered service in 1992 with the French Navy and Air Force, and there are reported export orders to Finland, Greece, and Oman. The French orders were for fitting to 'La Fayette' class frigates with 24 missiles each, and 12 fire units for the air force. It is believed that around 450 missiles were delivered to the French armed forces. The order for Finland was for 20 fire units mounted on SISU XA-180 (now PATRIA) APC vehicles, and is believed to have totalled 200 missiles. The order for Oman was to arm two 'Qhahir' class corvettes with 16 missiles each and a total of 80 missiles. The order for Greece was for nine fire units for the air force and two for the navy, with a total of 175 missiles. Greece was leased four fire units from France for training purposes in 2000, pending delivery of new missiles. It is believed that some fire-control systems were exported to South Korea to assist with their Chun-Ma (Pegasus) SAM development programme. The first 1,000 VT-1 missiles were manufactured in the USA with deliveries in 1991-92, production was then planned to be transferred to Euromissile in Europe, although no VT-1 missiles have been built since 1992. In 2001, Thales placed a new development and production contract for upgraded VT-1 missiles, but it is not clear how many will be built.

Specifications

	Crotale **R440**	Shahine **R460**	Crotale NG **VT-1**
Length	2.89 m	3.12 m	2.29 m
Body diameter	0.15 m	0.16 m	0.17 m
Launch weight	85 kg	100 kg	73 kg
Warhead	14 kg HE Blast/fragmentation	15 kg HE focused splinter	14 kg HE blast/fragmentation
Guidance	Command	Command	Command
Propulsion	Solid propellant	Solid propellant	Solid propellant
Range	10 km	15 km	11 km

Associated radars
Surveillance radars: Mirador 4 or TRS 2630 Griffon
Frequency: 2-3 GHz (S-band)
Peak power: n/k
Range: 30 km

Engagement radar
Frequency: 35 GHz (K-band)
Peak power: n/k
Range: 20 km

Missile command link: 8-10 GHz (X-band)

Contractor

Thales, Bagneux.

Akash

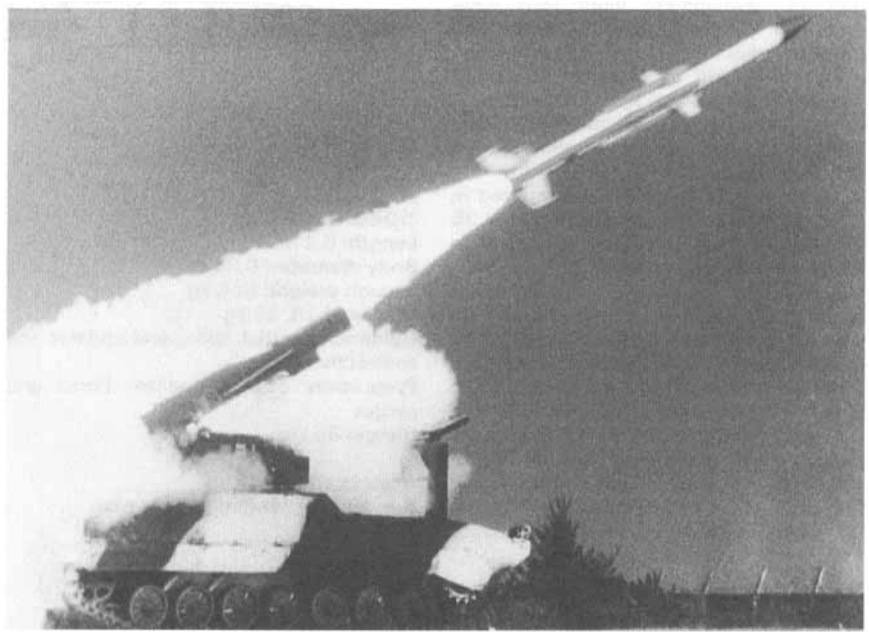
Type
Short-range, ground-based, ramjet powered, theatre defence missile.

Development
It is believed that the Indian Defence and Research Development Organisation (DRDO) began development of the Akash surface-to-air missile system under the Integrated Guided Missile Development Programme started in 1985. The purpose of the Akash programme was to develop a self-sufficient, short-range theatre defence missile to replace the Russian SA-6 'Gainful' SAM system that was in service in India. The missile, which has been developed for both ship-and ground-based use, is similar in appearance to the SA-6. A modified BMP-2 tracked vehicle has been developed as a launcher, carrying three missiles on a rotatable launcher assembly, similar to the SA-6 'Gainful' TEL vehicle. A 3D phased-array surveillance/ engagement radar has been developed by the Electronics Research and Development Establishment. The radar, which is called Rajendra, is also mounted on a modified BMP-2 tracked vehicle. The complete system has been designed to engage multiple targets, and is capable of tracking 64 targets and engaging four simultaneously.

The first test flight of Akash took place in 1990, and initial evaluation trials continued through to 2001. It was planned that Akash would replace SA-3 'Goa' (Pechora) missiles in service. There are reports that a modified system was proposed in 1996 to have a capability to intercept short-range ballistic missiles, but there have been no tests against ballistic missile targets and it seems unlikely that Akash will have this capability.

In 1997, DRDO indicated that Akash fire units would be integrated with the longer range surveillance radars of the SA-IO 'Grumble' system, and with airborne early warning aircraft. DRDO plans to improve the performance of the Akash missile to increase its speed, its maximum altitude, and the range to 60 km. A dual-mode radar/IR seeker is also reported to be in development. The new missile is believed to be called Akash 2. The Rajendra radar is expected to have its surveillance range increased to 200 km.


A Rajenda multifunction surveillance/engagement radar on its tracked vehicle 0051028


An Akash missile during a trials launch (DRDO) 0051029

Description
The Akash missile is similar in appearance to the Russian SA-6 'Gainful' missile, with four long slender tube ramjet air inlet ducts mounted mid-body between the wings. At mid-body there are four clipped triangular moving wings used for pitch and yaw control, and forward of the boat-tail there are four in-line clipped delta fins with ailerons for roll control. The missile is believed to be 6.1 m long, has a body diameter of 0.34 m, and a launch weight of 650 kg. The warhead is an HE fragmentation type with a lethal radius of 20 m against aircraft targets, and is reported to have a weight of 60 kg. The fuzes are a Doppler radar proximity fuze and a contact fuze. The missile is believed to be fitted with a C-band transmitter beacon mounted on the tail to assist the engagement radar in tracking the missile. The guidance system of the missile uses an inertial navigation unit, with command updates from the Rajendra radar in mid-course, and a semi-active radar seeker for the terminal phase that is used in the last 3 to 4 seconds of flight before interception. A solid propellant boost motor accelerates the missile in 4.5 seconds to a speed of M1.5 and is then jettisoned; at this point the ramjet motor is ignited and this burns for 30 seconds, accelerating the missile to M2.8. Akash has a minimum range of 5 km, and a maximum range of 35 km. Intercepts can be made against targets flying at altitudes between 50 m and 18 km. An unconfirmed report says that the maximum altitude has been increased to 25 km. The reaction time between target detection and missile launch is reported to be 15 seconds.

The Transporter-Erector-Launcher (TEL) vehicle is a modified BMP-2 tracked vehicle developed by Medak Ordnance, which has assembled and built over 800 BMP-2 vehicles in India under licence. The BMP-2 chassis has been lengthened to include seven rather than six axles. The three-missile launcher turntable is mounted on a raised structure behind the driver's station. The launcher is traversed to the front and

the missiles held in place by a restraining arm for travelling.

The Rajendra surveillance/engagement radar, which is similar to the Russian 30N6 (Flap-Lid B) used with the SA-IO 'Grumble' system, is mounted on a modified BMP-2 vehicle chassis. The multi-element antenna arrangement folds flat when the vehicle is moving, and is mounted on a raised platform behind the driver's station. The surveillance antenna array has 4,000 elements and operates at 4 to 8 GHz (C-band); the engagement antenna array has 1,000 elements operating at 8 to 12 GHz (X-band); and there is a 16 element IFF array The surveillance radar has a range of 120 km against aircraft targets, and can track 150 targets at altitudes between 30 m and 20 km altitude. The command and control vehicle is also mounted on a modified BMP-2 vehicle chassis. A standard Akash missile battery is expected to have four TEL vehicles, one Rajendra radar vehicle, and one command and control vehicle. The TEL vehicles can be separated by up to 25 km from the command and control centre vehicle. with communications provided by UHF radio and land lines.

An Akash SAM transporter-erector-launcher vehicle with three missiles, displayed in February 2001 (Craig Hoyle) ***2002***/0121873

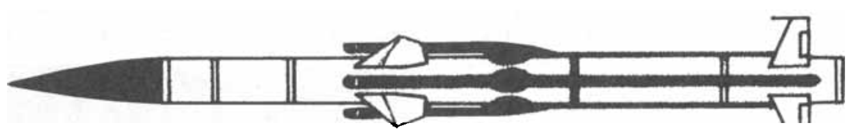


Diagram **of** *Akash missile* ***2002***/0121872

Operational status

The Akash missile was first tested in 1990, and 11 development flight tests were made up to March 1997. A further 30 missiles were used for initial evaluation from 1998, and by October 1999, 20 evaluation firings had been completed. A further eight firings were made in 2000/2001, and operational evaluation started in December 2001. Initial low-rate production is believed to have started in 2000 by Bharat Dynamics, at a rate of 25 missiles per year. Deliveries to the Indian Army are planned to start in 2001, and it is reported that the army and air force will receive 600 missiles each over the next ten years. It is expected that two flights of 12 missiles each will be located at each air force main base. There are unconfirmed reports that Akash missiles will be fitted to the second and third Delhi class destroyers being built for the Indian Navy instead of the SA-N-7 'Gadfly' missiles fitted to the first of class. The missile has been offered for export, but there are no known sales.

Specifications

Length: 6.1 m
Body diameter: 0.34 m
Launch weight: 650 kg
Warhead: HE 60 kg
Guidance: Inertial, command updates and semi-active radar
Propulsion: Solid propellant boost and ramjet
Range: 35 km

Associated radars
Surveillance/engagement radar: Rajendra
Frequency: 4 - 8 GHz (C-band) and 8 to 12 GHz (X-band)
Peak power: n/k
Range: 120 km

Contractors

The Indian DRDO at Hyderabad has developed the Akash missile; the Rajendra radar has been developed by the ERDE; and the modified BMP-2 vehicles were developed by Medak Ordnance. The missiles are being built by Bharat Dynamics Ltd, Hyderabad.

ADATS

Type

Short-range, ground-based, solid propellant, theatre defence missile.

Development

A 1975 study by Oerlikon-Buhrle of Switzerland (now the Oerlikon Contraves Division of Rheinmetall DeTec AG of Germany) led to an agreement with Martin Marietta (now Lockheed Martin) in 1979 to develop ADATS (Air Defence Anti-Tank System) as a private venture. The system was designed to defend against low flying aircraft, helicopters, UAVs, cruise missiles and also to attack armoured vehicles. In June 1981, the first firings took place at the White Sands Missile Range, New Mexico, and trials of the complete system started in 1982, with development completed in 1984. The Swiss Army tested ADATS in 1984; the US Army tested it in 1985 and it was selected for development to meet the Forward Area Air Defence Line Of Sight Forward Heavy (FAAD-LOS-FH) requirement in 1987. ADATS was given the US designator MIM-146, but the US Army programme was terminated in 1992. In June 1986, the Canadian Forces selected ADATS as part of the system to meet its requirement for a Low Level Air Defence System (LLADS). Tracked vehicle and sheltered variants of the ADATS missile system have been developed. A shipborne system, called Sea Sprint, was proposed in 1997 for fitting to ships as an inner layer defensive weapon system. An upgraded ADATS was offered in 2000 in a composite missile and 35 mm cannon defensive system called Skyshield 35, designed to defend against low-RCS targets such as cruise missiles and UAVs.

A Canadian ADATS launch vehicle displayed in March 1997 (Duncan Lennox) 0010182

Description

The ADATS missile has four small clipped delta folding control fins at the rear end. The laser guidance beam receivers are located on two opposite fin tips. The missile is 2.05 m long, has a body diameter of 0.152 m and weighs 51.4 kg at launch. The hollow-charged dual-purpose warhead weighs 12.5 kg, with the casing providing a fragmentation effect against aircraft and the shaped charge providing a penetration capability of up to 900 mm of armour against ground targets. The warhead is detonated by either an impact fuze (ground targets) or a laser proximity fuze for air targets, with the facility selected by the operator before launch. The missile is accelerated to M3.0, propelled by a single-stage low-smoke solid propellant motor that weighs 30 kg and contains 24 kg of propellant. It is capable of maximum manoeuvres of 60 g and has a range of up to 10 km. The maximum altitude for engagement of airborne targets is 7,000 m. The missile is stored and loaded in a canister that has a length of 2.2 m, a diameter of 0.24 m and weighs 16 kg when empty. The ADATS system consists of a 360° traversable turret fitted with: a surveillance radar; Forward Looking Infra-Red (FLIR) and TV trackers; laser range-finder; and a carbon dioxide missile guidance laser. There are four missile launcher containers carried on either side of the turret, which has been installed on M113 and M3 Bradley tracked vehicles. The launcher turret can also be installed on an air mobile container, or simply on a ground-mounted flat steel platform. When mounted on the flat platform, the turret with four missiles loaded weighs 3,480 kg. The M113 vehicle has a maximum road speed of 60 km/hr, a length of 5.7 m, a width of 2.86 m and a height of 3.9 m with the surveillance radar antenna raised to the operating position. The turret can engage targets with elevations from –10 to +90°. Two control consoles, one for the radar operator and the other for the electro-optics (gunner) operator, are placed inside the vehicle. Airborne targets are detected by the X-band pulse-Doppler dual-beam surveillance radar, the antenna of which rotates through 360" at 57 rpm. The radar is fully coherent and frequency agile between 8.5 and 9.5 GHz and is capable of track-while-scan on 10 targets simultaneously, from 50 to 8.600 m

A front view of an ADATS launch vehicle showing the surveillance radar antenna on top of the central sensor assembly, with the large left-hand window used for the FLIR, the upper centre for the TV camera/laser range-finder, the upper right for the IR missile localiser (tracker), and the lower right window for the missile guidance laser beam (Duncan Lennox) 0010181

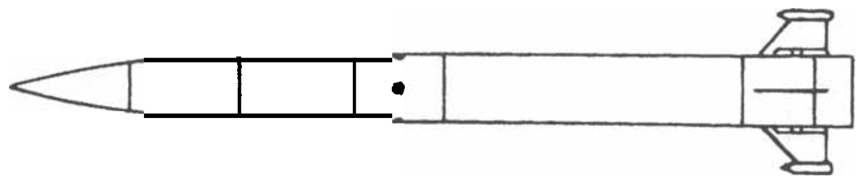
altitude and out to a range of 25 km. The radar has an automatic IFF/SIF interrogator, and can strobe onto jamming. The long-range FLIR operates between 8 and 12 µm and the shorter-range visual system uses a near IR vidicon TV with a 1.06 µm laser range-finder. The output of FLIR and/or TV sensors appears on the display operated by the gunner. Once a target is designated as hostile by the radar operator, following IFF interrogation, the turret is automatically slewed to the target's bearing, and a search is initiated to bring it into the field of view of the FLIR or TV camera, both of which are installed in a bin on the front of the turret between the missiles. The gunner then selects either the FLIR or TV for tracking, depending on the light level and prevailing weather conditions. The selected sensor then 'locks on' to the target and begins automatic tracking. The range is measured either by the laser range-finder, or is provided by the track-while-scan facility of the surveillance radar. Once the target is in range, a missile is launched and commanded to the line of sight. It then becomes a beam-rider within the field generated by the 10.6 µm wavelength, digitally coded CO, laser beam.

When the missile is used in the surface-to-surface mode, ground targets are acquired electro-optically and the range is determined by the laser range-finder. The remainder of the engagement sequence is the same.

The ADATS system can integrate up to six fire units into a low level air defence network, covering 20 targets and with the components separated by up to 20 km when using radio links. The whole system has built-in test equipment, and the missile has a life of up to 15 years.

Operational status

Production of the ADATS missile system at the Oerlikon Contraves plant, near Montreal in Canada, started in June 1986. In November 1986, the US Army announced that Martin Marietta (now Lockheed Martin), together with Oerlikon Contraves (now part of Rheinmetall DeTec AG). had been selected as the winner of the contract for the FAAD-LOS-FH system. The first four pre-production vehicles were delivered in 1989 for operational testing and evaluation. This was due to be completed by mid-1990, but was extended to improve reliability. Approval for low rate production of the US Army's 358 fire units had been delayed until 1992, and the US Army programme was terminated in the same year. By 1996, it was reported that there had been over 200 live firings of ADATS missiles. ADATS was in production at Oerlikon Contraves for CF-LLADS, and the first system was delivered to the Canadian Armed Forces in October 1988.



A line diagram of the ADATS missile

An ADATS missile displayed beside a shelter mounted launcher at Paris in 1995 (Peter Humphris)

The entire Canadian LLADS order was for 36 ADATS fire units and these were initially deployed to protect Canadian air bases in Germany, with the ADATS mounted on M113 series vehicles. It was reported in October 1989 that the Royal Thai Air Force was negotiating the purchase of 10 to 20 fire units to be integrated with their Skyguard systems, but only one shelter based system was ordered in 1994 and this has been located at Korat airbase. The first Thailand evaluation firing of an ADATS missile was made in June 1999.

Specifications

Length: 2.05 m
Body diameter: 0.15 m
Launch weight: 51.4 kg
Warhead: 12.5 kg HE shaped charge and fragmentation
Guidance: CLOS
Propulsion: Solid propellant
Range: 10 km

Contractor

Oerlikon Contraves Inc, Rheinmetall DeTec AG, Saint Jean-sur-Richelieu, Canada.

Aster 15/30

Type

Short- and medium-range. ground- or sea-based, solid propellant, theatre defence missiles.

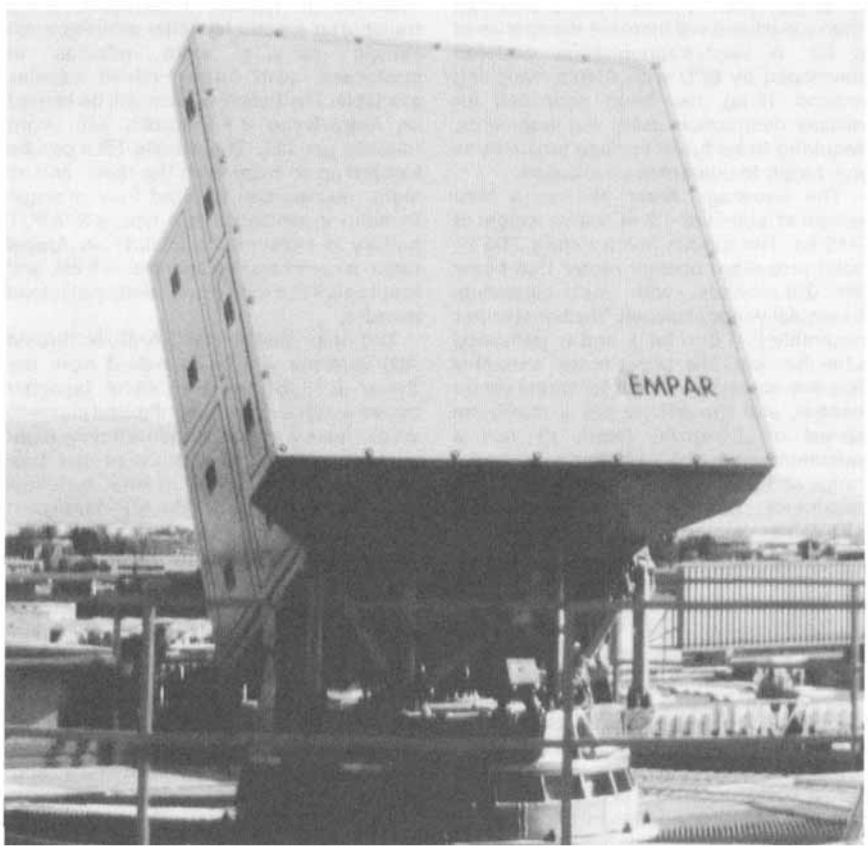
Development

Feasibility studies for the French SYRINX programme *(systemerapide interarmees* **a** *base d'engins et fonctionnant en bande X:* X-band fast tri-service missile system) were carried out from 1982-1984. Pre-development contracts were awarded in 1984 to Thomson-CSF (now Thales) for the Arabel radar and fire-control system and to Aerospatiale (now MBDA Missile Systems) for the Aster missile. These were followed by full development contracts in 1988 and 1990. The SYRINX system became known as the Future Surface-to-Air Family (FSAF) (*famille de systèmes anti-ariens futur*), and was designed to defend against aircraft, air-to-surface, surface-to-surface and cruise missiles, and to attack ship targets, with the possibility of further development to defend against short-range ballistic missiles. In 1989 a consortium, Eurosam, was established to manage the FSAF programme, now called Aster, with Aerospatiale, Alenia Difesa (now both MBDA Missile Systems) and Thomson-CSF (now Thales) as partners. Four Aster missile versions are planned. SAAM *(systernenaval dautodefense anti-missile:* naval surface-to-air anti-missile system), to be met by the Aster 15; SAMP/T *(systeme dautodefense moyen* ***portee:*** land-based medium-range surface-to-air missile) and SAMP/N *(systeme d'autodéfense rnoyen portée:* ship-based medium-range surface-to-air missile), which will both be met with the Aster *30.* A fourth version, to be capable of intercepting short-range ballistic missile targets, is being developed, and will be known as Aster 30 block 1. An improved version to intercept longer range ballistic missile threats, has been proposed, and will be known as Aster *30* block *2.* The SAMP land and naval versions will have additional sensors to augment the Arabel radar, including a secondary search radar and optical systems to assist with identification and provide better performance in heavy ECM environments. A full-scale development contract, signed in 1988, covered work on the Arabel and EMPAR radars, fire-control system and Aster 15 missile for short-range ship defence (SAAM). A second development contract, placed in 1990, added the Aster 30, SAMP/T and Arabel radar systems for the medium-range land-based system.

The UK examined FSAF for both its MSAM land-based and SDMS ship-based requirements, and in 1993 agreed to a common Principal Anti-Air Missile System (PAAMS) based upon improved Aster 15 and Aster *30* missiles. PAAMS is a joint French, Italian and UK project for use on the French Horizon and Italian Orizzonte air defence frigates, and the UK's Type 45 destroyers. A consortium, called EuroPAAMS, was formed with the original Eurosam contractors plus UKAMS, a consortium between Matra BAe Dynamics, GEC-Marconi (now both MBDA Missile Systems) and Siemens Plessey (now BAE Systems). A full engineering development and initial production contract was placed with EuroPAAMS in August 1999, with initial deliveries of three ship sets planned for 2005. A Spanish consortium proposed to join FSAF in 1991, but dropped out in 1992 due to lack of Spanish Government funding.

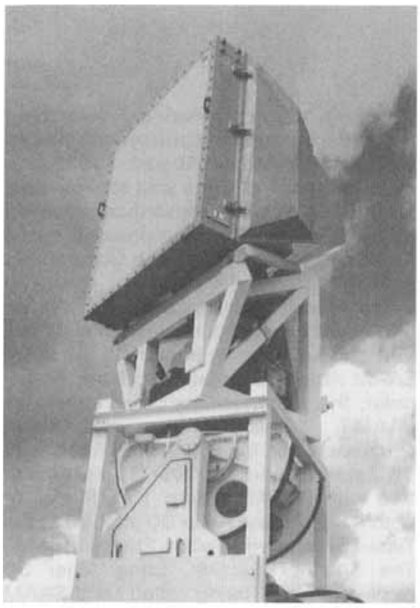
The French aircraft carrier, *Charles de Gaulle,* will be equipped with four eight-cell Vertical Launch Systems (VLS) using SAAM Aster 15 missiles and the Arabel radar, this configuration being known as SAAM-F. French Horizon and Italian Orizzonte class frigates will be fitted with 16 Aster 15 and *32* Aster *30* missiles in VLS with EMPAR radars. The UK will fit both Aster 15 and Aster 30 missiles to the Type 45 destroyers, with a Sampson radar. The SAMP/T version, using Aster *30* missiles, is now being called Land SAAM AD, and the SAMP/N is being called Naval SAAM AD.

Tests were made in 1995 to research the possibility of including an integral rocket-ramjet motor for Aster *30* for extended-range versions, and in 1996 proposals were made to develop a dual-mode imaging IR and active radar seeker for a multirole Aster version, for use against both short-range ballistic missiles and air-breathing targets. In 1998 a proposal was made to upgrade the Aster *30* SAMP/T (Land SAAM AD) missiles and radar to a block 1 standard before delivery. The changes were agreed, and development started in 2000. The block 1 upgrade includes larger warhead fragments

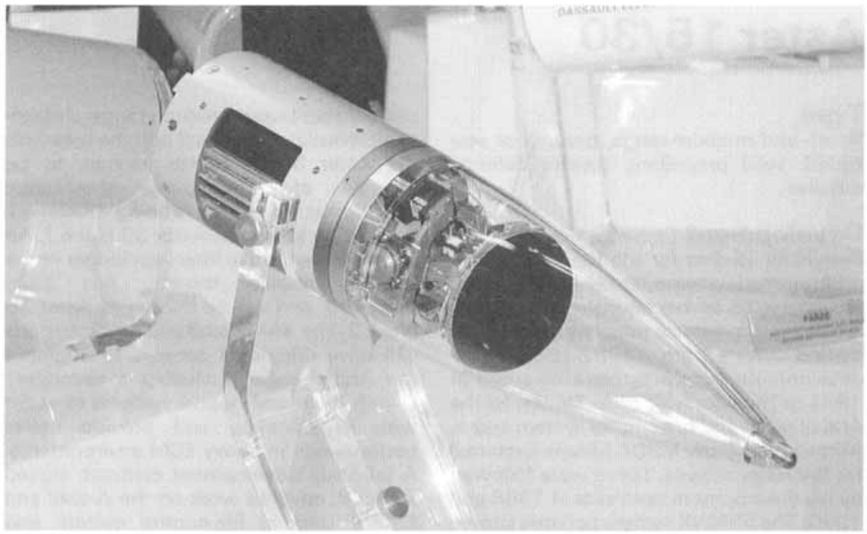


A trials EMPAR multifunction radar (Alenia) 0044952

An Aster 30 missile trials launch in July 1999 (DGA-CEL) ***2001***/0100715



A development model of the Arabel 3-D multifunction radar



The AD4 guidance assembly and antenna for the Aster missile. This seeker is also used in the MICA air-to-air missile (Duncan Lennox) 0010180

directed towards the target, modified seeker, fuze and signal processors in the missiles. The Arabel radar will be upgraded to accept higher speed and higher altitude targets, giving the block 1 system a capability against short-range (up to 600 km) ballistic missile targets as well as aircraft, ASM and UAV targets. In 1999, a proposal was made to upgrade some Aster 15 SAAM missiles to a block 1 standard, to provide a multirole capability against either short-range ballistic missiles or aircraft and cruise missiles, but this has not been agreed. Further improvements to Aster 30, known as block 2, were examined in 2001 to provide a capability against ballistic missile threats with ranges up to 1,500 km. A block 2 version would need improved boost and sustainer motors, probably an IIR seeker, and may be modified to be able to be launched from Mk 41 VLS as well as Sylver launchers on ships. A block 2 missile would only be used against ballistic missile targets, and would need modified surveillance and engagement radars. A larger boost motor, designated Aster ER, was proposed in 1999 to increase the range of Aster 30 to 150 km, in addition to earlier Aster 45 or Aster 60 designs.

Description

The Aster missile is vertically launched and has a tandem first-stage solid propellant booster that is discarded in flight. A common second-stage missile is mounted on different first-stage booster motors, the shorter-range Aster 15 (SAAM) and the longer-range Aster 30 (SAMP/T or SAAM AD) systems. The second-stage missile itself is 2.6 m long, has a body diameter of 0.18 m and a weight of 107 kg. The missile has four long rectangular wings and four moving clipped-tip triangular control fins at the rear. The second-stage missile has a Celerg solid propellant sustainer motor. Additional manoeuvrability in the final flight phase is provided by a gas generator, exhausting through four lateral nozzles in the wings close to the missile's centre of gravity (pilotage en force-PIF), with the capability to pull up to 50 *g*. Guidance in the mid-course phase is inertial, with the addition of target position updates from the radars, aiming to fly the missile out on a reciprocal course to that of the incoming target. An active radar terminal phase seeker uses a Dassault Electronique (now Thales) and GEC-Marconi Dynamics (now MBDA Missile Systems)-developed homing head derived from the MICA air-to-air missile seeker AD4 design. The active radar seeker incorporates a home-on-jam capability, as well as clutter suppression for attacking sea-skimming missiles. The Aster missile has a weight of 70 kg at interception, and will damage the target if it hits. The missile has been designed to hit its target, but if a close miss is expected then a warhead will increase the chance of a kill. A blast/fragmentation warhead developed by BPD with Alenia, weighing around 15 kg, has been optimised for missile destruction using 4 g fragments, requiring to be fuzed in close proximity to any target to guarantee destruction.

The two-stage Aster 15 has a total length at launch of 4.2 m, with a weight of 310 kg. The missile has a Celerg 203 kg solid propellant booster motor that burns for 2.5 seconds, with four clipped-tip triangular wings attached. The boost motor assembly is 1.6 m long, and is jettisoned after burning. The boost motor assembly has two steerable nozzles for thrust vector control, and the missile has a maximum speed of 1.0 km/s. Aster 15 has a minimum range of 1.7 km, and a maximum range of 30 km against aircraft targets. The maximum range against small sea-skimming missiles is expected to be around 5 km. The minimum intercept altitude is 5 m, and the maximum altitude for interception is 15 km.

The two-stage Aster 30 has a total length of 5.2 m, and a weight of 510 kg at launch. The Aster 30 missile has a larger but similarly shaped BPD booster motor, weighing 403 kg, that burns for 3.5 seconds to give the missile itself both higher velocity and longer range. This boost motor assembly is 2.6 m long and has two steerable nozzles for thrust vector control. Aster 30 missiles have a maximum speed of 1.4 km/s. The missile has a maximum range of 100 km against aircraft flying at between 3 and 10 km altitude. If the aircraft are flying below 3 km or above 10 km altitude, then the maximum range is reduced to around 50 km. The maximum range is around 15 km against sea-skimming missiles. The minimum range at all altitudes is around 3 km. Aster 30 will be able to engage targets at altitudes between 50 m and 25 km. The vertically launched missiles are reported to have an intercept capability against steep-diving air-to-surface missiles, and short-range tactical ballistic missiles or surface-to-surface rockets with a range of less than 100 km. The land SAMP/T (SAAM AD) version in French service is expected to be mounted on Renault TRM10.000 6 × 6 transporter-erector-launcher vehicles, each vehicle carrying eight missiles in containers, with further reload missiles available. The Italian version will be carried on Astra/Iveco 8 × 8 trucks, with eight missiles per TEL. The missile TELs can be located up to 5 km from the radar, and all eight missiles can be fired from a single launcher in ten seconds. A typical SAMP/T battery is expected to include an Arabel radar, a command and control vehicle, and four to six TELs with some additional reload missiles.

The ship SAAM and SAMP/N (SAAM AD) versions will be launched from the Sylver A43/50 vertical naval launcher systems, which can be configured in one to six modules with each module having eight missile canisters. The modules can take either Aster 15 (SAAM) in A43 launchers or Aster 30 (Naval SAAM AD) missiles in A50 launchers within a height of 6.0 m, width of 2.6 × 2.3 m, and a total weight of 8,000 kg. The delay between missile launches is 0.5 seconds. Each missile in a module has its own launch canister and deck hatch.

The Thales Arabel X-band (8 to 13 GHz) radar is a multifunctional surveillance, tracking and missile guidance 3-D phased-array radar, scanning 360° in azimuth and 75° in elevation. Incorporated in the radar is a missile uplink transmitter. The same radar is planned for use with both the Aster 15 (SAAM-F) and Aster 30 (SAMP or Land SAAM AD and Naval SAAM AD) systems.

The Arabel radar can track up to 100 targets and manage command updates to 16 missile engagements simultaneously. This radar uses pulse compression and frequency agility for ECCM and can extract Doppler from the returns. A rectangular phased-array antenna has 2,600 elements and rotates at 60 rpm. The beam can be shaped and there is constant analysis of ECM and noise environments. The GEC-Marconi and Alenia (now Alenia Marconi Systems) and Thales EMPAR passive element phased-array C-band (4 to 6 GHz) radar uses Doppler with a wide bandwidth, frequency agility and pulse compression, and has 360° coverage at 60 rpm. The radar provides an uplink to the missile. EMPAR will be used by the Italian Navy in a similar role for the SAAM-I system, and this radar has an acquisition range of 100 km against a small aircraft target. The radars include IFF/NIS identification modules, and there is an unconfirmed report that EO sensors will be added to counter ECM. SAMP/T (Land SAAM AD) is planned to have a Zebra zenithal radar to cover steep-diving missiles directly above the Arabel radar location, providing cover of 40" about the vertical In addition to the Arabel and EMPAR radars, it is expected that a long-range surveillance radar will be used with the Aster ship-based systems, and it is planned that the Alenia Marconi Systems S1850M radar, an improved Hollandse Signaalaparaten Smart-L radar, will be fitted to the Horizon frigates and Type 45 destroyers. This 3-D radar has a range of up to 400 km, and operates at 1 to 2 GHz (L-band).

The SAAM, SAMP/T and SAMP/N (SAAM AD) systems use common MARA (Modular Architecture for Real-time Applications) computers and MAGICS (Modular Architecture for Graphics and Image Console Systems) consoles.

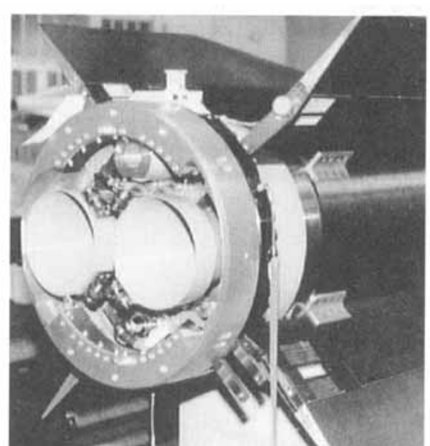
PAAMS will use improved Aster missiles, believed to be a combination of upgraded or standard Aster 15 and Aster 30 missiles. The EMPAR or BAE Systems Sampson multifunction engagement radars will be used, EMPAR on the French and Italian frigates, and Sampson on the UK destroyers. The Sampson multifunction radar operates at 2 to 4 GHz (S-band) using an active array system, with 2,500 elements on each of the two faces, rotating at 30 rpm. The Horizon frigates and Type 45 destroyers will use the A50 Sylver vertical-launch system, with six modules carrying a total of 48 missiles.

Operational status

The Aster missile system entered full-scale development in 1988, and initial flight trials started in 1989. Development test firings of Aster 15 missiles started in 1990, and of Aster 30 in 1993. A prototype Sylver VLS was tested on land and then on a trials ship in 1993-94. Development and evaluation trials planned for the period 1995 to 2003, were scheduled to incorporate some 40 trials of both Aster 15 and Aster 30 versions. Successful trials were reported in 1997, with Aster 15 intercepting an MM 38 Exocet missile sea-skimming target at 9 km range, and an Aster 30 missile intercepting a C-22 target flying at 11,000 m altitude and at 30 km range. Qualification trials for the SAAM/FR were completed in October 2001, and six qualification trials for SAAM/IT will be carried out in 2002/2003 from the trials ship *Carabiniere.* The in-service date for the SAAM (Aster 15) system is planned for 2002, with installation onboard the French aircraft carrier *Charles* ***de*** *Gaulle.* Two operational evaluation trials are planned for 2002/2003 from the aircraft carrier. Full-scale production for Aster 15 missiles is planned to be achieved by 2002, with a rate of 180 missiles per year.

Full-scale development contracts for the Aster 30 missile and SAMP/T (Land SAAM AD) version were placed in 1990, with qualification firing trials started in January 1999 and operational evaluation trials planned to start in 2004. An in-service date

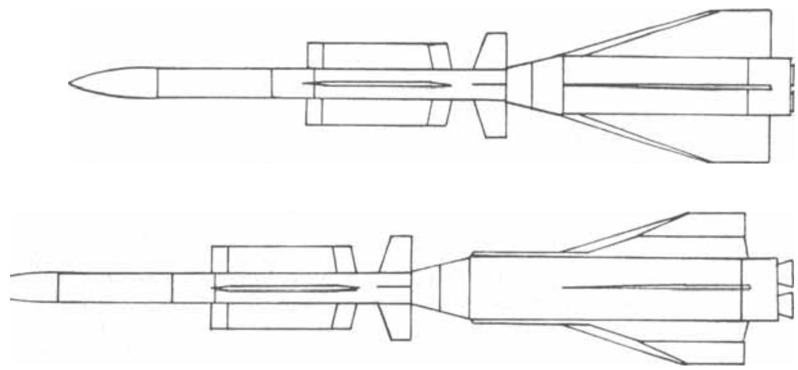
Models of an Aster 15 missile (right) and Aster 30 (left), showing the different size boost motor assemblies (Duncan Lennox) 0044953



The two thrust vector control nozzles on the base of the Aster 30 boost motor assembly (Eurosam)

of 2005 is expected, possibly with a block 1 capability. Present orders for the SAMP/T (Land SAAM AD) include 8 systems for the French Army, 7 for the French Air Force, and 12 for the Italian Army, with an in service date of 2006. The PAAMS naval system received early development funding in 1996, and a full-scale development and initial production contract was awarded in August 1999 for three ship sets, with 40 Aster 15 and 80 Aster 30 missiles ordered. Initial deliveries of the ship sets are planned to start in 2005, with operational qualification trials following in 2005/2007. The total Aster 15 and Aster 30 missiles ordered by October 2000 was over 400, and a further order for 900 missiles is expected.

In 1997, the first export order for Aster was placed by Saudi Arabia, with an order for three ship sets of Aster 15 (SAAM) missiles, Arabel radars and Sylver launchers for three Sawari 2 class F3000S frigates. Each frigate will have two 8-missile vertical-launch modules plus some reload missiles. A production order for 100 Aster 15 (SAAM) missiles was placed with Eurosam in 1997, with 40 for the French Navy and 60 for the Royal Saudi Arabian Navy. Singapore is believed to have ordered six ship sets of Aster 15 (SAAM) for their new frigates, for delivery from 2005.



A line diagram of the two Aster missiles: upper diagram is SAAM (Aster 15) and lower diagram SAMP/T/N (Aster 30)

Eight hatches for the Sylver vertical launch system on the 'Charles de Gaulle' aircraft carrier. The second group of eight had not been installed when this picture was taken in 1999 (Josh Corless) **2001**/0033629

Specifications

Aster **15**
Length (including booster): 4.2 m
Body diameter (booster): 0.32 m
Launch weight: 310 kg
Missile length: 2.6 m
Missile diameter: 0.18 m
Missile weight: 107 kg
Warhead: 15 kg HE fragmentation
Guidance: Inertial, command and active radar
Propulsion: Solid propellant
Range: 30 km

Aster 30
Length (including booster): 5.2 m
Body diameter (booster): 0.38 m
Launch weight: 510 kg
Missile length: 2.6 m
Missile diameter: 0.18 m
Missile weight: 107 kg
Warhead: 15 kg HE fragmentation
Guidance: Inertial, command and active radar
Propulsion: Solid propellant
Range: 100 km

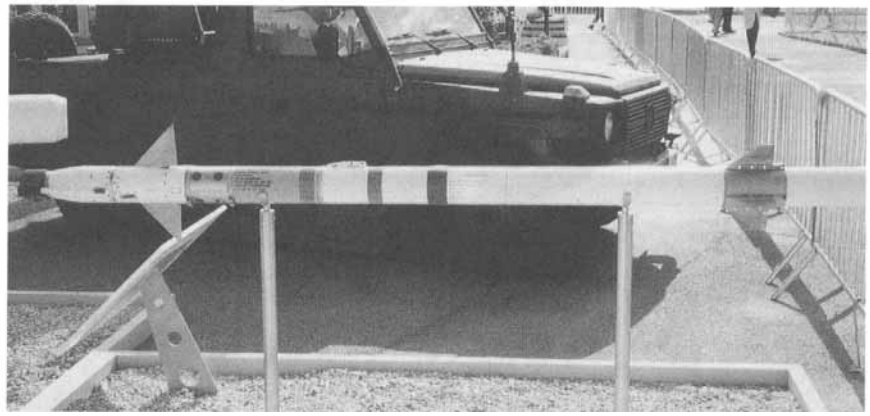
Associated radars
Surveillance/Engagement: Arabel
Frequency: **8-1**3 GHz (X-band)
Peak power: 100 kW
Range: 100 km

Empar
Frequency: 4-6 GHz (C-band)
Peak power: n/k
Range: 100 km

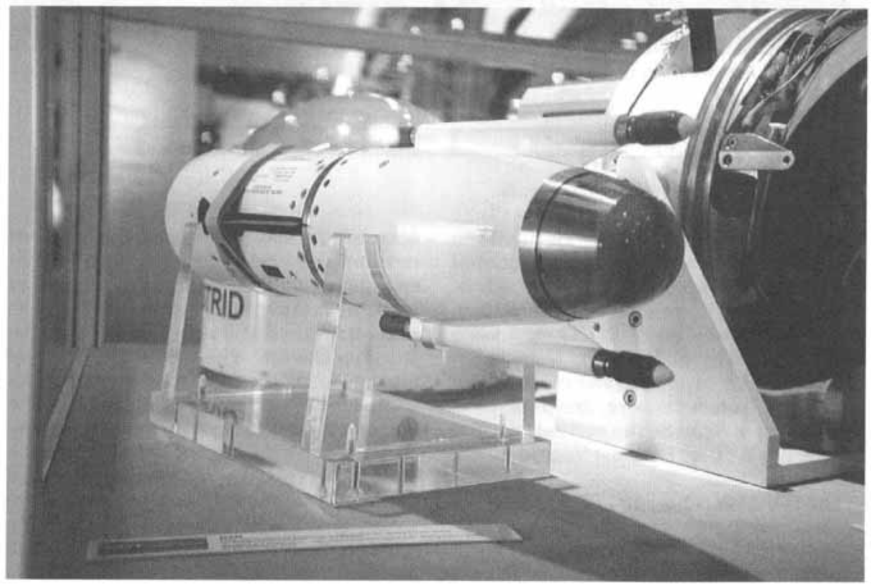
Contractors

MBDA Missile Systems, Chatillon Cedex, France.
Thales, Bagneux, France

RIM-I16 RAM



A RAM (RIM-116A) missile on display at Paris in 1997 (Duncan Lennox) 0044955



The guidance assembly of the RIM-1 16A missile. showing the ***central IR*** *seeker dome with the two* ***RF antenna*** *horns above and below* (Peter Humphris) 0010179

Type

Short-range, ship-based, solid propellant, theatre defence missile.

Development

The Rolling Airframe Missile (RAM), designated RIM-1 16, originated from a US Navy requirement for an Anti-Ship Missile Defence (ASMD) system to supplement Phalanx and Sea Sparrow. The requirement was for a low-cost, fast response, high fire power, anti-ship missile defence system designed around existing components. The initial design of RAM used the AIM-9 Sidewinder air-to-air missile warhead and rocket motor with a dual-mode passive radar and infra-red seeker, for use against anti-ship missiles that are using active radar terminal seekers. Originally it was planned as a US programme and development began in 1974, but Congressional doubts about the programme slowed development. In July 1976, Germany signed a Memorandum of Understanding (MoU) to share development costs and later Denmark joined the consortium with a two per cent share. A contract for a 50 month full-scale engineering development programme was signed in June 1979. Missile flight testing took place in the early 1980s and, in October 1982, a RAM successfully intercepted a drone representing an anti-ship missile in poor visibility over land. In the same month, seaborne trials began and in February 1983 there were three consecutive successful interceptions of drones, including a supersonic drone.

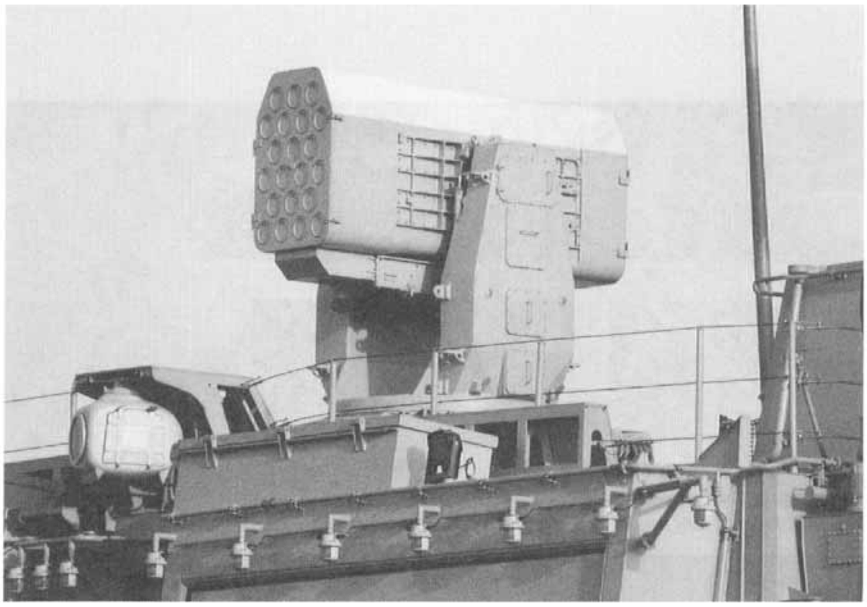
In July 1987, the USA and Germany signed a further MoU for low rate initial production of the RAM Block 0 system, designated RIM-I16A. The German systems are produced by RAM Systems GmbH, a consortium comprising DASA LFK (now part of EADS), BGT and Diehl. The RAM weapon systems are co-produced by Hughes Missile Systems (now Raytheon Missile Systems) as prime contractor and RAM Systems as subcontractor, while the German company competes against the US company for the manufacture of up to 70 per cent each of the launchers and missile components needed by both US and German navies.

An improved missile, known as the RIM-I 16B RAM Block 1 programme, provides an image scanning IR seeker and an improved active laser proximity fuze. The new seeker is known as the Infra-Red Mode Upgrade (IRMU) and is added to the initial dual-mode seeker, to provide the option of tracking an incoming missile that is not using radar guidance. This version will be supported by a ship-mounted FLIR for detection and launcher alignment. The new guidance in the Block 1 missile is for use against non-radiating IR-guided anti-ship missiles, and may also be used against aircraft, helicopters or small surface ships. A software change will enable the Block 1 missile to be used against aircraft, helicopter and surface targets, and this is known as the HAS programme upgrade. The USN were reported to be examining an enlarged motor upgrade to increase range and terminal manoeuvrability in 1994, with tests carried out in 1995, and a digital datalink to update the missile in flight. This programme, known as Block 2, is still being evaluated. A new lightweight launcher is being developed, with 11 missiles, for the US Navy. The US Navy also plans to use RIM-116 missiles in their Ship Self Defense System (SSDS), which connects Sea Sparrow, RAM, Phalanx guns, decoys, chaff and jammers by a fibre optic local area network. An upgrade to the Phalanx CIWS has been proposed by Raytheon and RAM Systems, known as Sea RAM. This upgrade replaces the existing Phalanx 20mm six barrel gun with an 11-round RIM-116B missile launcher, together with an improved Ku-band engagement radar, an X-band ESM receiver and a HDTI 5-2F 8 to 12 micron FLIR.

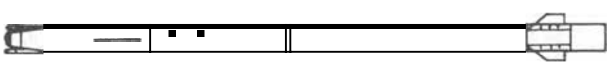
The German RAM systems are fitted to 'Lutjens' class (Type 103B) destroyers with two 21-cell launchers, to 'Bremen' class (Type 122) and 'Brandenburg' class (Type 123) frigates with two 21-cell launchers, and to 'Gepard' class (Type 143A) fast attack craft with one 21-cell launcher. The German Navy plans to fit RAM to their 'Sachsen' class (Type 124) frigates. A total of 28 German ships are planned to be fitted with the RIM-116 system. The US Navy fitted a trials RIM-116 installation on the amphibious assault ship USS ***Peleliu,*** and have fitted two 21-cell launchers to a number of 'Tarawa' class amphibious assault ships. It is reported that the USN plans to fit RIM-116 systems to 83 ships, including LHA, LHD, LSD, LPD, destroyers and cruisers. There are also proposals to fit launchers on 'Whidbey Island' class dock-landing ships and aircraft carriers, as part of an integrated Ship Self-Defense System (SSDS).

Description

The initial standard RIM-116A RAM Block 0 missile is a composite of new and off-the-shelf missile parts. It uses the AIM-9 Sidewinder air-to-air missile airframe, warhead and rocket motor, a Sidewinder-derived laser-pulsing proximity fuze, an IR seeker from the FIM-92 Stinger, and a contact fuze derived from the US Navy's RIM-66/67 Standard missile. Among the new components are the passive RF detector, RF antennas, autopilot and foldaway control surfaces. The missile has four small folding clipped delta fins at its



A RIM-1 16 Mk 49 missile launcher, with 21 missiles (van Ginderen) 0044954



A line diagram of the RIM-1 16 missile

rear, and incorporated in the new guidance section are two retractable delta control fins and two RF antennas on either side of the IR dome. The missile is 2.82 m long, has a body diameter of 0.127 m, a wing span of 0.44 m and weighs 73.5 kg at launch. RAM is given a rolling motion from within the launch canister, and this roll is maintained in flight by the control fins. The missile has a 10 kg HE blast fragmentation warhead.

The RAM Mk 31 guided missile weapon system comprises the Mk 49 launcher, together with 21 loaded missiles in Mk 8 canisters, and the control consoles. The Mk 49 launcher carries 21 missiles in a sealed container that weighs 5,180 kg for the above deck and 937 kg for the below deck components. This launcher can move 360° in azimuth and from −25 to +80° in elevation. A RAM Alternate Launch System (RALS) has also been developed for smaller ships, which carries 11 missiles in a launch assembly that weighs 3,735 kg for the above deck and 760 kg for the below deck components, with a ±175° movement in azimuth and the same elevation as the Mk49 launcher. RAM can also be used with the NATO Sea Sparrow Mk 29 launcher, with insert racks fitted into two of the eight Sea Sparrow cells to hold the RAM missile canisters. Five RAM missiles will then fit each cell, a configuration known as RAM ORDALT. The existing ship's radars, ESM or electro-optical systems locate and designate the target and the missile is launched at a selected elevation in the direction of the target. Once the missile is launched, it needs no support from the mother ship, and achieves lock-on after launch. Even if the search radar fails after launch the RAM will proceed on course. In a multi-target engagement, the fire-control computer feeds new information to the launcher as soon as the first missile fires, and the launcher slews to a new firing position and fires again. As the missile emerges from its launcher it is spun by rifle bands inside the launch canister to simplify guidance. Once clear, its tail fins and front movable steering surfaces unfold in rapid succession and it flies a preprogrammed course towards the target, until the RF receiver locks on to the target's active radar seeker. When a sufficient IR signal to noise ratio is achieved, guidance control is transferred to the IR seeker which then homes in on the incoming missile's heat emissions. The Block 0 missile can be used to home all the way on active radar emissions from the target, or can use IR homing all the way if the target is within range of the seeker. The missile itself is capable of manoeuvres up to 20 *g* in any direction, has a maximum range of 10 km and a maximum intercept altitude of 12,000 m.

The RIM-116B RAM Block 1 missile has a dual-mode passive radar and an 80 element image scanning infra-red seeker. This version can home all the way onto infra-red emissions from the target from a greater range, and can be targeted against aircraft, helicopters or small surface ships. The Block 1 missile has an improved active laser fuze for use against very low flying targets in all weather conditions. The US Navy have ordered Mk 20 Mod 2 Thermal Imaging Sensor Systems (TISS) to serve as a passive surveillance and engagement system for the RAM against anti-ship missile threats.

Operational status

RIM-116A entered service with the US Navy in 1992, having been installed for trials on USS ***Peleliu,*** an amphibious assault ship. A trials launcher was fitted by the German Navy on a Type 143 fast attack craft in 1983, but an initial missile production order was only placed in 1990, for 350 missiles. During Block 0 development 80 missiles were fired, 11 were fired in technical evaluation and over 140 production missiles have been tested. Two Block 1 missiles were tested in 1997, a successful intercept of a MM-40 Exocet missile was made in December 1998, and of a steep diving Vandal target in April 1999, as part of the initial evaluation of this version. A further 40 operational evaluation missiles have been launched, with 23 of the final 24 interceptions successful. The Block 1 missiles started in low-rate initial production in 1998, and full production was started in 2000 with an initial order for 90 missiles. RIM-116B missile systems are expected to enter service in 2002, and will probably be delivered as upgrade kits for the existing in-service missiles. Evaluation trials for Sea RAM began in 2001, and for the aircraft, helicopter and surface target mode (HAS) in 2002. By October 1999, over 100 RAM systems and 2,500 missiles had been ordered, and it is believed that current production will continue for a total of 115 launchers and 3,000 missiles. In late 2000, RIM-116 missile systems had been fitted to 30 US Navy ships, and to 25 German Navy ships. The US Navy ordered a further 45 Mk 49 launchers and missiles in May 2000, for delivery up to 2004. It is expected that 80 US ships and 28 German ships will eventually be fitted with the system.

Denmark may take up an option to purchase RAM systems later, with plans to install two Mk 29 launchers on their 'Niels Juel' class frigates. A report in 1995 indicated that Japan plans to purchase some RIM-116 missiles, but to date this has not been confirmed. South Korea ordered three Mk 49 launchers and missiles for fitting to their KDX batch 2 destroyers in 1999, and ordered further missiles in 2001. In July 2000, Greece ordered three Mk 49 launchers and missiles for their new FACs.

Specifications

Length: 2.82 m
Body diameter: 0.127 m
Launch weight: 73.5 kg
Warhead: 10 kg HE blast/fragmentation
Guidance: Passive RF and IR (Block 0) or Passive RF and IIR (Block 1)
Propulsion: Solid propellant
Range: 10 km

Contractors

RAM Systems GmbH, Ottobrun, Germany.
Raytheon Missile Systems, Tucson, Arizona, USA.

MIM-120 NASAMS (AdSAM and ASAM-I)

Type

Short-range, ground-based, solid propellant, theatre defence missiles.

Development

In the late 1980s. Norway, in seeking to resolve its air defence requirements, decided to investigate the possibility of using a combination of existing components, including a ground-launched version of the AIM-120 AMRAAM missile and an advanced 3-D radar. The Norwegian Advanced Surface-to-Air Missile System MIM-120 (NASAMS) initially replaced the two aging MIM-14 Nike facilities. However, NASAMS was also a logical replacement for the NOAH (Norwegian Adapted HAWK). In 1989, Hughes Aircraft Company (now Raytheon Missile Systems) and Norsk Forsvarsteknologi AS (now Kongsberg Defence and Aerospace) were awarded a one-year design and test contract for phase 1 of the NASAMS programme. Phase 1 called for incorporating and testing a ground-launched AMRAAM with the Hughes TPQ-36A advanced 3-D radars, and Norwegian fire direction systems of the type deployed as part of the NOAH upgrade. The first of two ballistic test firings to be conducted in this phase was successfully carried out in September 1989. In 1990, the Norwegian Government approved full-scale development of the NASAMS, with phase *two* (a three year contract to produce a prototype fire unit with radar and *two* launchers) also being awarded in the same year. A variant of the MIM-120 system was offered to the UK for their MSAM requirement in 1992, called AdSAM, which incorporated the TPQ-36A radar and a derivative of the Siemens Plessey (now BAE Systems) MESAR active array radar. The UK requirement was cancelled in 1993.

An MIM-120 NASAMS launch from the modified MIM-23 HAWK launcher, during trials in 1995 (US Army)

A second missile variant was known as ASAM-I, and was similar to MIM-120 but had a larger rocket motor to give greater range. In 1993, a joint US/Norwegian proposal was made to upgrade MIM-23 HAWK systems with the integration of MIM-120 AMRAAM missiles, and trials were started in 1995 with eight MIM-120 missiles fitted to a standard HAWK launcher, for a system now known as HAWK-AMRAAM. A joint US Army and USMC project was started in 1996 to fit five MIM-120 missiles to an M1097 heavy High Mobility Multipurpose Wheeled

A MIM- 120 four-missile launcher fitted to a HMMWV light utility vehicle for the CLAWS programme (Raytheon) ***2002***/0121870

A trials launch of the ASAM-I missile; basically a MIM- 120 variant with a larger rocket motor

Vehicle (HMMWV) for possible future use by US forces, and this has been called HumRAAM. Trials launches were made in 1996 and 1997, with three live firing trials made in 1997 by the US Marine Corps. A US Army test in July 1998 used a HumRAAM launcher located behind a hill, with an AN/MPQ-64 Sentinel radar tracking the target in front of the hill and relaying the launch data to the HumRAAM. An alternative HMMWV installation was proposed in 1999, with four MIM-120 missiles mounted on a rotating launcher assembly. A total of nine missiles has been tested from the HumRAAM vehicle up to mid 1999. A fire distribution centre vehicle has also been designed, to control up to eight HumRAAM launchers, which can be separated by as much as 20 km. The US Army is considering the implications of converting some Avenger and Linebacker vehicles, and HMMWV armed with FIM-92 Stinger SAMs, to the HumRAAM configuration, possibly with the option to fire different missiles from a common launcher. The USMC were also looking at a possible MIM-120 system, called the Complementary Low Altitude Weapons System (CLAWS), and placed a development and pre-production contract with Raytheon in April 2001, for two HMMWV each carrying four missiles on a rotating launcher. It is expected that the HumRAAM and CLAWS requirements will be put together into one system solution that is C-130 transportable.

Proposals were made in 2000 for an integrated PAC-3 and MIM-120 missile solution for the international MEADS project, using common launchers. A NASAMS 2 upgrade was also being proposed by Raytheon and Kongsberg in 2000, improving the missiles and replacing the radar with the AN/MPQ-64.

A NASAMS six-box ground launcher vehicle elevated to the firing position, shown at the 1992 Farnborough Air Show (Duncan Lennox)

AN/TPQ-36A air defence radar, part of the Norwegian Advanced Surface-to-Air Missile System

Description

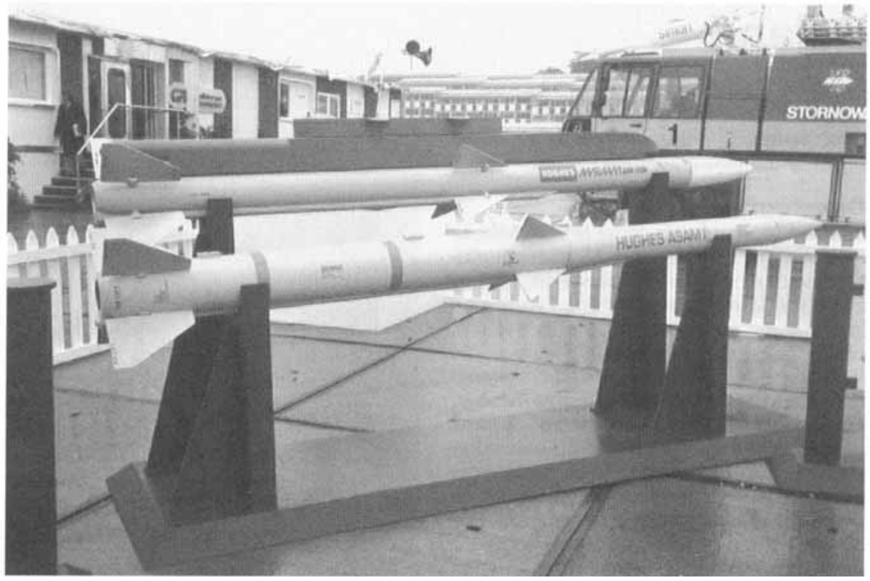
The MIM-120 NASAMS missile is an off-the-shelf AIM-120 AMRAAM, which is 3.65 m long, has a body diameter of 0.18 m and a fin span of 0.63 m. The fixed central wings have a span of 0.53 m. The missile weighs 157 kg and has a low-smoke solid propellant boost and sustainer motor. The warhead weight is around 22 kg, with directed fragments initiated by an active radar proximity fuze. Control is by four rear-mounted fins, moved by electrically powered actuators. Initial guidance is by on-missile inertial navigation, followed by an active radar terminal phase. The seeker operates in X-band (8 to 10 GHz). There are variable PRF and frequency capabilities, as well as a home-on-jam facility against self-screening jammer targets. An integrated microprocessor is used in the missile combining the functions of navigation, autopilot, datalink reception, terminal radar, fuzing and built-in test.

In operation the missiles are maintained in a 'cold' or unpowered condition until a firing command is initiated by the fire direction centre. Once received at the launcher, this command activates the missile start sequence, including a built-in test that checks 70 per cent of the system, and launches the missile in 1.4 seconds. The navigational system mounted on the launcher provides initial position data to the AMRAAM inertial unit, which guides the missile towards its target location during the early flight phase. The missile seeker activates in mid-course, acquiring and tracking the target in a high Pulse Repetition Frequency (PRF) mode until switching to a medium PRF during the terminal phase. The active radar has a capability to look down into ground clutter and still locate the target. A typical NASAMS battery would comprise four fire units, each with its own TPQ-36A three-dimensional radar, three launchers (each with six missiles) and one fire direction centre. The AN/TPQ-36A (also known as ARCS (Acquisition Radar and Control System) and used with the Norwegian MIM-23 HAWK system), is a low-altitude search and track X-band radar, which uses 3-D pencil beams and frequency-agile phase beam scanning in order to provide accurate target range, bearing and elevation cueing data to the manned field Fire Distribution Centre (FDC). As the rectangular planar-array antenna rotates (at 30 rpm), the computer controls the pencil beams in both axes so that the complete surveillance volume, extending to 75 km in range and more than 15,000 m in height, is searched. This volume is scanned at different rates. The search pattern is contoured so that it follows the horizon even in mountainous terrain, and searches the horizon every two seconds because of the high threat of pop-up targets. The TPQ-36A can detect small fighters out to some 60 km, and shares energy between its search and tracking functions. This type of radar is important to AMRAAM, which requires 3-D

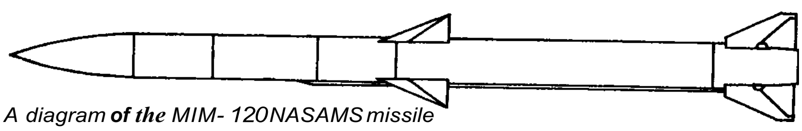
targeting data before launch, its seekers being unable to function with two-dimensional radars. While the performance characteristics of the NASAMS are classified, it would be expected to be at least comparable to the MIM-23 HAWK, which has a maximum range of 35 km and altitude of 18,000 m. It is reported that NASAMS launchers can be located up to 25 km forward of the radar and fire direction centre, and that the system has an 'up and over' trajectory capability to engage low flying targets behind obscuring terrain features. A NASAMS launcher can be re-loaded in 20 minutes.

The hybrid MIM-23 HAWK/MIM-120 NASAMS system, HAWK-AMRAAM, fits eight AMRAAM missiles to a converted HAWK launch vehicle. A hybrid unit will comprise an AN/MPQ-64 'Sentinel' 3-D surveillance radar, an Air Defence Operations Centre (ADOC), an AN/MPQ-61 HAWK phase 3 high-power illuminator radar, two standard HAWK launchers carrying three missiles each, and two modified launchers carrying eight AMRAAM missiles each. The ADOC will be carried on an HMMWV, and this has been developed and built by Kongsberg in Norway.

The ASAM-I proposal had a larger boost motor, larger wings and a weight at launch of 227 kg. The diameter of the larger boost motor was 0.23 m, and this produced a distinctive taper just forward of the wings. This missile probably had a range of 45 km.



Models of the MIM- 120AMRAAM (upper missile) and ASAM-1 (lower missile) shown at Farnboroughin 7992 (Peter Humphris)



A diagram ***of the*** *MIM- 120NASAMS missile*

Operational status

Phase 1 of the NASAMS development programme started in 1989 and the first successful ground firings of the missile, using a standard F-16 aircraft missile rail launcher mounted at a 30° elevation, was carried out in September 1989. Phase 2, a three year development programme, started in 1990 and this produced two systems, one for use by the Norwegian military to develop and verify field tactics and personnel requirements, the other for test and trials firings in the USA. The first trial against a drone target was made at Pt Mugu in April 1993. Two NASAMS batteries were scheduled for delivery to Norway and deliveries started in 1994. NASAMS entered service in Norway in 1997, and Norway has 54 launchers and a total of 360 missiles. A final operational test of NASAMS was made in the USA in August 1998, with an integrated ground-based air defence system comprising NASAMS and RBS-70 missiles with L70 anti-aircraft guns. NASAMS will eventually replace all Norwegian HAWK and RBS-70 batteries, and in 2001 it was reported that three batteries of NASAMS would be retained long term in Norway at Bodo, Orland and Rygge. An upgraded NASAMS 2 system was planned for the Royal Norwegian Army with transfers of equipment from the RNoAF starting in 2004. The NASAMS 2 system was to be mounted on Hagglunds Bv 206 tracked vehicles with six missiles fitted to 12 launchers together with four FDCs and six TPQ-36 radars. It is unclear if this programme will proceed. The ASAM-I variant, with a larger rocket motor, was first test launched in 1992 and this was proposed as a possible contender for the US Corps SAM programme. The hybrid HAWK-NASAMS system was first tested in the USA in 1995 and has been offered for export. Firing trials of NASAMS fitted to HMMWV have been made since 1996, with a 'beyond line of sight' trial successfully carried out in July 1998. Two missiles were tested from a HMMWV in October 2001, as the start of the CLAWS programme for the USMC, and it is planned that the USMC will order 95 launchers and 1,000 missiles for an in-service date of 2004/2005.

In May 2000, Egypt requested NASAMS. Outline approval was given by the USA, although it was stated that the MIM-120 missiles would be modified so that they could not be used in the air-to-air mode. In September 2000, Spain ordered four NASAMS fire units, with four FDCs, four AN/MPQ-64 radars and eight launchers.

Specifications

MIM-120 NASAMS
Length: 3.65 m
Body diameter: 0.18 m
Launch weight: 157 kg
Warhead: 22 kg HE directed fragmentation
Guidance: Inertial and active radar
Propulsion: Solid propellant
Range: 35 km

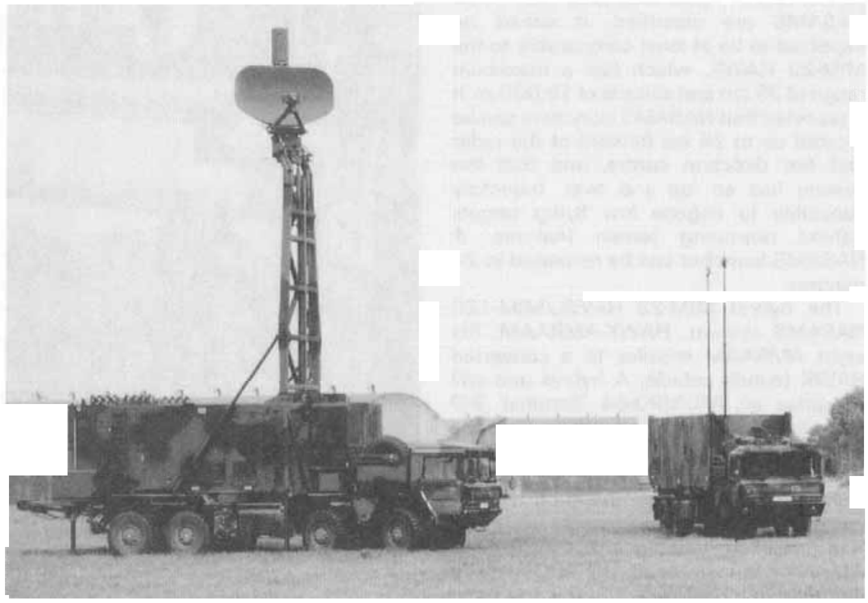
ASAM-I
Length: 3.7 rn
Body diameter: 0.23 m, boost motor; 0.18 m, forebody
Launch weight: 227 kg
Warhead: 22 kg HE directed fragmentation
Guidance: Inertial and active radar
Propulsion: Solid propellant
Range: 45 km

Associated radars
Engagement radar: AN/TPQ 36A
Frequency: 10-12 GHz (X-band)
Peak power: n/k
Range: 60 km

Contractors

Kongsberg Defence and Aerospace, Norway.
Raytheon Missile Systems, Tucson, Arizona, USA.

Roland



A Roland weapon system elevated surveillance radar (left) and fire control vehicle (right) (DASA)
200010079442

Type

Short-range, ground-based, solid propellant, theatre defence missile

Development

In 1964, Aerospatiale (now MBDA Missile Systems) of France and Messerschmitt-Bolkow-Blohm (now LFK Systems, part of EADS) of Germany began design work on a low altitude surface-to-air missile system, which eventually became known as Roland. Aerospatiale had overall responsibility for the clear-weather version, called Roland 1, and MBB overall responsibility for the Roland 2 all-weather version. At a later stage, a joint company called Euromissile was established to market these and other missiles produced by the two companies. The first Roland 1 production hardware began evaluation trials with live firings in 1976.

The French Army system is based on the AMX-30 MBT chassis, designated AMX-30R, and the first of these fire units with Roland 1 missiles were delivered to the French Army in 1977. Roland 1 missiles entered full production in 1978. The first Roland 2 firing trials units were delivered to the former West German Army in 1978 and, in 1981, they officially took delivery of the first Roland SAM systems as replacements for the towed 40 mm L/70 Bofors guns. Full production of the Roland 2 missile started in 1981. A shelter version of the Roland system was also developed, and Argentina used one of these during the Falklands (Malvinas) War of 1982 to defend Port Stanley against air strikes.

A version known as 'US' Roland evolved as a result of the US Army evaluating the Thomson-CSF (now Thales) Crotale, Euromissile Roland and the British Aerospace (now MBDA Missile Systems) Rapier in 1975. Roland was selected by the US Army for its short range all-weather air defence system (SHORADS) for licence production in the USA. The fire unit was modified for mounting on an M812A1 6 × 6 5-ton cross-country truck, which is the version that was used by a New Mexico Army National Guard unit until 1988. Production of the 'US' Roland commenced in the United States in 1979, but was terminated by Congress in 1985 after 27 Roland fire units and 595 missiles had been built.

A different configuration also evolved to meet the needs of the German Air Force and Navy, and US Air Force bases in Europe, known as the FlaRakRad Roland. The first Euromissile production FlaRakRad Roland was officially handed over to the German Air Force and Navy in 1987.

In mid-1985, Euromissile revealed the development of an updated system known as Roland 3. Principal differences between this model and its predecessors were that the Roland 3 missile had increased range, higher speed and a heavier warhead. The dimensions were unchanged, so that the Roland 3 rounds could be handled and fired from existing fire units. A new launcher system allowed four missiles to be fired without requiring any reload operation, instead of two as before. Each launch vehicle was able to carry 12 missiles instead of the former 10. Other modifications included a new digital processor system (including self-test) that could be used with both Roland 2 and 3 missiles. New interface units that permitted connection to a co-ordination centre (CORAD), exchange of target data with other Roland systems, and target designation to other attached weapon systems such as AAA guns and man-portable surface-to-air missiles. Roland 3 entered full production in 1988 and is believed to have entered service with the French armed forces that same year.

Roland FlaRakRad (8 × 8) configuration in operational mode with both tracking and surveillance antennas erected (Euromissile)

In 1987, Matra Defense (now MBDA Missile Systems) initiated a study of a missile called MISSAT, whose purpose was to replace both Crotale and Roland missiles. This initiative led to a tri-lateral consortium being created. In 1990, it was announced that the consortium was to develop a new hypervelocity short-range SAM, to be designated the RM5 (Roland Mach 5). This missile would be capable of countering threats including supersonic aircraft, helicopters performing pop-up manoeuvres and battlefield unmanned airborne vehicles. The new missile was also to be compatible with existing modernised Roland fire units. However, the RM5 programme was terminated in 1991, when Euromissile planned to adopt the Thomson-CSF (now Thales) VT-1 missile design from the Crotale NG system to upgrade Roland fire units.

In 1988, the French and German MoDs decided to adopt an upgrade programme for their Roland fire units in order to maintain the systems in service until 2010 and beyond. The programme included: the replacement of the current optical sight by

the Glaive electro-optical sighting system, giving Roland a third engagement mode (visual, radar, and IR); simplification of the man-machine interfaces by use of the BKS fire control system, and a microprocessor-based turret and computer assembly for the fire unit. This programme was delayed, and by 1999 only France funded what was called Enhanced Roland upgrades, with the first trials firing taking place in March 2000. Germany placed a development contract in September 2000 for a reduced life extension programme, introducing a digital fire-control system, improved test and training equipments, and an upgraded datalink.

In 1992, Euromissile announced the completion of a prototype Roland M3S system, which it had developed as a private venture specifically for the export market The prototype of this shelter-mounted system was initially mounted on the rear of a Multiple Launch Rocket System full-tracked carrier chassis, although it can also be mounted on a wide range of other chassis (tracked or wheeled) and may be adapted for the air-transportable vehicle versions The standard Roland M3S has four Roland missiles in the ready to launch position, with an engagement radar and EO sighting system The system was designed so that other missiles such as the Mistral, FIM-92 Stinger, or the Crotale NG VT-1 could replace some or all of the Roland missiles.

In 1994, the family of Roland systems expanded again with the first air-transportable version being completed These systems are based on the Lohr vehicle-mounted or towed shelter-mounted Roland system that can be transported inside C-160 Transall or C-130 Hercules transport aircraft The new lightweight aluminium shelter incorporates some parts from the existing Roland 2 SAM system with new cabling, an air conditioning system and a new auxiliary power unit to make the system autonomous In 1997, it was reported that the Roland M3S system would use an Ericsson 3-D surveillance radar, a new tracking radar, the Glaive EO sensor suite and the Crotale NG VT-1R missile However, in February 2001 Thales started development and production of an upgraded VT-1 missile for Crotale NG In

Roland missile being launched from a German Army Roland 2 system based on the Marder I chassis (Euromissile)

1998, a proposal was made by BGT for the HFK/KV research hypervelocity missile to be used as a replacement for Roland 3 missiles, using the same launchers and interface equipments. LFK have proposed an alternative missile. designated HFK/L, and flight trials have been made on both HFK options during the late 1990s More details of these two HFK programmes can be found in the Unclassified Projects section.

Description

The Roland missile is common to all the launch unit systems and all three variants have the same external appearance. They are stored and delivered in a container, which also serves as a launcher tube. The missile has a cylindrical body with a long taper to a sharply pointed nose. Just aft of mid-body there are four large folding delta-wings and forward on the nose taper are four fixed in-line smaller delta fins On two opposite wing trailing-edges are the command signal and beacon signal antennas. Roland 1 and 2 are 2.4 m long, have a body diameter of 0 163 m, a wing span of 0 5 m, and a launch weigh 66.5 kg. The hollow charge warhead weighs 6 5 kg, including 3 3 kg of explosive which is detonated either by impact or a continuous wave (CW) proximity fuze. Maximum lethal radius of the warhead's 65 projectile charges is given at 6 m plus from detonation point. Propulsion is by a two-stage solid propellant rocket motor. The 1.7 second burn, 1,600 kg thrust SNPE Roubaix boost motor accelerates the missile to 500 m/s. The 13.2 second burn, 200 kg thrust SNPE Lampyre sustainer rocket motor, located in front of the boost motor, ignites 0.3 seconds after booster burnout. Minimum flight time required by the weapon to arm itself is 2.2 seconds, giving a minimum range of 500 m. The maximum flight time of around 13 to 15 seconds, gives the Roland 2 missile a maximum range of 6 km. The minimum intercept altitude is 10 m, and the maximum altitude is 5,500 m. Guidance control/steering is achieved through the use of vanes in the efflux from the sustainer motor.

The Roland 3 missile has the same dimensions as the earlier models, but weighs 75 kg at launch. Its warhead, which weighs 9.2 kg, contains 5 kg of explosive and 84 projectile charges to increase its lethality without any change in dimensions. An improved proximity fuze, coupled with a new 5,000 m/s maximum velocity fragmentation pattern, increases the lethal radius of the warhead. The Roland 3's improved propulsion system gives it a maximum speed of 570 m/s. The minimum range is 500 m, and the maximum range is **8** km. The maximum interception altitude is 6,000 m.

The complete Roland 1 or 2 system consists of a surveillance radar, an engagement radar, an optical sight, an IR radiometer, a fire-control computer, a microwave command datalink and the missiles. In operation, target detection in azimuth is performed by a pulse-Doppler surveillance radar on the launch vehicle. This radar has a range of up to 16 km against aircraft-sized targets. Threat evaluation is accomplished with a single antenna scan, and IFF facilities are provided by either a MSR-400/5 (Germany) or an LMT (France) interrogator. The weapon system commander is also the operator of the acquisition radar. The operator selects the target and, in the Roland 1 configuration, directs the optical sight to the target azimuth. The gunner then searches in elevation and acquires the target, whereupon a missile may be launched. After launch the gunner maintains the Line of Sight (LOS) to the

A Roland 3 missile showing the cotnmaiid guidance antenna on the rear of the wings, and the twin motor nozzles at the base of the missile (Duncan Lennox) 0010176

target and the missile is gathered to the LOS and guided along this track by an IR guidance technique. In the Roland 2 configuration, an engagement radar is used in addition to a periscope sight. Otherwise, the principle of operation is the same. The Roland 2 missile system can be used either in the clear weather mode or all-weather mode. In the latter mode, the radar tracks both the target and the RF beacon on the missile; the fire-control computer generates the correction signals, which are then transmitted to the missile via the datalink. The sighting modes can be switched, in missile mid-flight, if it becomes necessary due to Electronic CounterMeasures (ECM), battlefield smoke and so on. In all variations the operating principle is the same. The tracking unit tracks the target and missile, and generates steering signals to the missile. The Roland system has been mounted on the French AMX-30R, the German SPz Marder and M975 and the USA M812A1 6 × 6 chassis. Additionally, several 'sheltered' versions are in existence including the FlaRakRad Roland. This version is characterised by an eight-wheeled military chassis (15T MAN) on which a special Roland shelter is mounted. The latest system to be introduced is a lightweight shelter version that is air-transportable. For this, the French Army uses an ACMAT (6 × 6) tractor truck towing a Lohr semi-trailer on which the shelter can slide, and the German Army uses a Lohr shelter mounted on a six-wheeled 10T MAN truck.

The Carol shelter system uses a standard ISO container, retains the Roland 2 tracking and surveillance radars, can be transported by rail or by C-130 and C-160 aircraft. The system weighs 8,300 kg without missiles, and in addition to the two Roland SAMs in the ready to launch position, a further eight are carried in two four-round revolver type magazines. The missiles are automatically loaded from the magazines onto the two launcher rails.

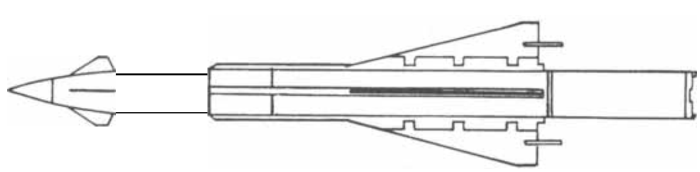
The new Crotale NG VT-1R missile, planned to be used in the Enhanced Roland system for the French Army, is described in the Crotale entry. The missile is 2.29 m long, has a body diameter of 0.17 m and a launch weight of 73 kg. The missile has a 14 kg blast fragmentation warhead, and uses CLOS guidance. The maximum range is 11 km. The Enhanced Roland will have a TRML-3D surveillance radar with a range of 25 km, and an altitude coverage up to 9 km. This radar operates in X-band (8 to 10 GHz) with track-while-scan, frequency agility and ECCM, and can track up to 50 targets. The engagement radar operates in the Ku-band (35 GHz) and has a maximum range of 20 km. The GLAIVE electro-optical sighting system has a TV camera, FLIR and a laser range-finder, for passive operation of the Roland system or when the system is subjected to ECM.

Operational status

Roland 1 entered service in 1978, Roland 2 in 1981 and Roland 3 in 1988. A total of 680 launchers and over 26,000 missiles have been ordered.

Roland 3 is still in production and Roland missiles are in service with the following countries: Argentina, Brazil, France, Germany, Iraq, Nigeria, Qatar, Spain, USA and Venezuela. In 1988, Euromissile stated that the Roland order book stood at 644 launch vehicles (231 AMX-30, 148 Marder, 234 Shelter and 31 US Army) and 25,000 missiles. By late 1996, over 3,400 Roland missiles had been fired in trials, training and combat. A Shelter version was used by Argentina during the Falklands war to defend Port Stanley. The system fired eight of the 10 missiles it carried, and is known to have shot down one Sea Harrier. Iraq also used a similar system in the 1980-88 war with Iran. The US Army National Guard unit equipped with 'US' Roland was deactivated in 1988. The 21 US owned Roland fire units, located in Germany, were handed over to Germany in February 1998.

The first Roland air-transportable system was completed in 1994 and it is reported that a total of 20 of these have been produced for the French Army and 10 for the German Air Force Rapid Reaction Forces. The first Glaive (IR) prototype system was tested in 1996. The Enhanced Roland development and initial production contract was awarded in December 1999, five flight demonstration tests were completed in 2000/2001, and operational qualification flights started in 2002. Four Enhanced Roland in Carol shelters and four on AMX-30 chassis will be used for the operational qualification flight tests. Enhanced Roland is expected to enter into service in 2003 with the French Army, with up to 72 Roland 2 fire units to be upgraded to the new standard (52 on AMX-30 and 20 Carol shelter versions). It is unclear if the French upgrade will include the VT-1 missiles. The Roland 1 units are to be phased out of service by France. The German upgrades entered development in 2000, and are expected to start production in 2003. It is believed that 115 of the present 253 German fire units will be upgraded. In 2001 Slovenia ordered a battery of six launchers to Roland 2 standard, to be provided by the German Navy.



A line diagram of the Roland missile

French Army Roland air-transportable sheltered SAM system being towed by ACMAT (6 × 6) tractor truck (Aerospatiale)

Specifications

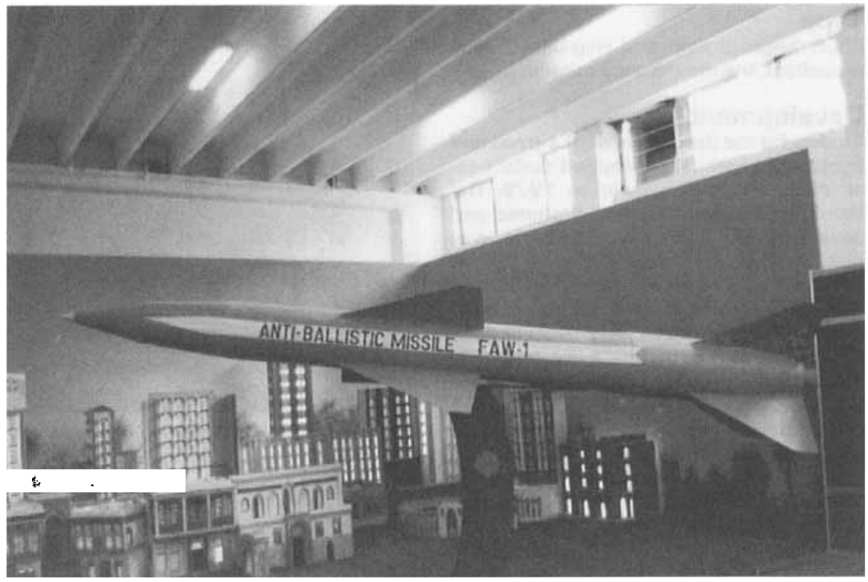
Roland 1 & 2
Length: 2.4 m
Body diameter: 0.16 m
Launch weight: 66.5 kg
Warhead: 6.5 kg HE
Guidance: Radio-command LOS
Propulsion: 2-stage solid propellant
Range: 6 km

Roland 3
Length: 2.4 m
Body diameter: 0.16 m
Launch weight: 75 kg
Warhead: 9.2 kg HE
Guidance: Radio-command LOS
Propulsion: 2-stage solid propellant
Range: 8 km

Contractor

MBDA Missile Systems, Fontenay-aux-Roses, France.

FAW-1



A mode! of the FAW-7 theatre defence missile. shown at the Baghdad exhibition in April 1989 (Tony Banks)

Type

Short-range, ground-based, solid propellant, theatre defence missile

Development

Little was known about this Iraqi development programme until a model of FAW-1 was shown in April 1989 at the Baghdad exhibition. It was reported that a successful trial had been completed earlier in 1989, which would have been in addition to the Iraqi modified SA-2 'Guideline' firing against an SS-1 'Scud' target in February 1989. While the Iraqi government claimed that FAW-1 was an indigenous project, there were reports of assistance from Egypt and China.

Description

FAW-1 bears a close resemblance to the Chinese surface-to-air missile system HQ-61, although the wing and fin shapes are different. The model exhibited in 1989 showed clipped-tip delta-wings and fins, with relatively long root chords when compared to the near triangular wings and fins on the HQ-61. Assuming that FAW-1 is similar to HQ-61, then the missile would be about 4.0 m long, with a body diameter of 0.29 m, a wing span of 0.8 m and an estimated launch weight of 300 kg. The missile most probably has semi-active radar guidance, with a CW monopulse system to give a better low-level performance. However, Iraq has used Russian built SAMs against aircraft on several occasions with command guidance directed by electro-optical sensors, to avoid anti-radar missiles attacking the SAM sites. The motor would most probably be solid propellant, with an expected range of about 10 km.

From the size and brief details released on the FAW-1 missile, there is no possibility that this system would have any capability against short-range ballistic missiles as claimed.

Operational status

It is not known when development started on the FAW-1 project, nor whether it is totally Iraqi designed or built with assistance from one or more partners. One flight test does not necessarily indicate a mature development programme and, following the Gulf War in 1991, the status of this project would seem to be in doubt. No further reports on the programme have been seen since 1989, except for unconfirmed reports that Iraq has developed several new missile systems since 1991. Given the track record of innovative designs in Iraq, it is quite possible that a more capable SAM system has been designed since 1991, and might have been tested following the withdrawal of UN inspectors in August 1998.

Specifications

Length: 4.0 m
Body diameter: 0.29 m
Launch weight: 300 kg
Warhead: HE fragmentation
Guidance: Semi-active radar
Propulsion: Solid propellant
Range: 10 km

Contractor

Not known.

Barak/ADAMS/' Relampago'/Defender

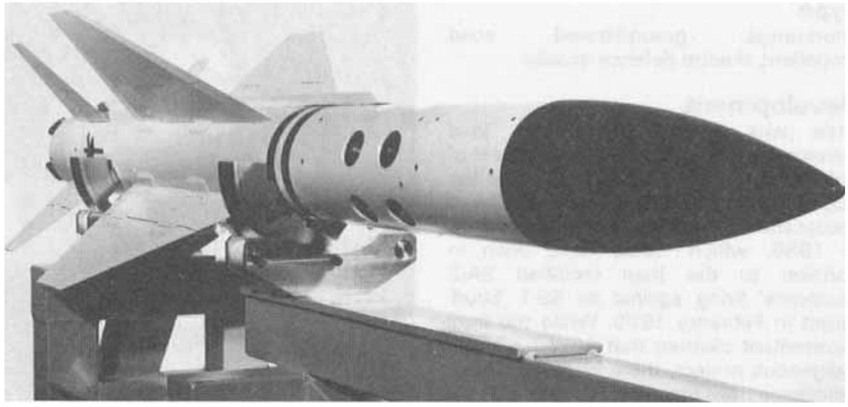
Type

Short-range, ground- and ship-based, solid propellant, theatre defence missile.

Development

Studies for the development of a small and lightweight vertically launched surface-to-air missile started in Israel in 1979. The Barak 1 ship-based system, designed and developed jointly by IAI and Rafael, was first seen at the 1983 Paris Air Show. Vertical launch trials started in 1984, and the first trials engagement of a simulated sea-skimming missile was successfully completed in 1986. Sea trials began in 1989. Barak is being fitted to 'Hetz' class fast attack craft (Saar 4.5) with 16 or 32 cell vertical launchers, and to 'Eilat' class corvettes (Saar 5) with two 32 cell vertical launchers for the Israeli Navy. The missile is also being fitted to 'Prat' (ex-UK 'County') class destroyers with two octuple launchers for the Chilean Navy, and Singapore is adding two octuple Barak launchers to its 'Victory' class corvettes. A scaled-up version of the Barak missiles, designated AB-IO was proposed as a short range ATBM in 1987, but this programme was terminated in 1989. A ground-based version, known as ADAMS (Air Defence Anti-Missile System), was reported to be in development in 1991, with up to 12 vertically launched missiles carried on an 8 × 8 wheeled vehicle together with the tracking radar and an electro-optical sensor for use in heavy ECM environments. Hughes Missile Systems (now Raytheon Missile Systems) proposed the ADAMS missile combined with the Phalanx gun as the HVSD/ADAMS for the US DoD high value site defence system. In 1994, a ground-based Barak system was again offered for export, this time called 'Relampago' and mounted on an 8 × 8 wheeled vehicle with 12 missiles in VL canisters and engagement radar with EO tracker. The 'Relampago' system was reported to be capable against aircraft, helicopters, missiles and UAVs.

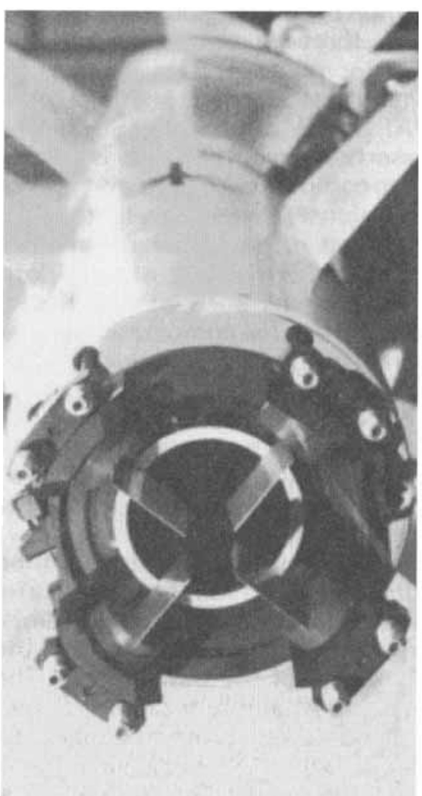
An export order to Venezuela, announced in 1998, is believed to incorporate the 'Relampago' system with Signaal Flycatcher Mk2 weapon control systems. Lirod Mk2 radars and Mirador EO sighting systems. In 2001 a ground-based version called Defender, was proposed for use by NATO countries, with the introduction of NATO standards through a joint teaming arrangement with Thales.



An early development Barak 1 niissile. showing the active lasei fuze windows forward of the wings

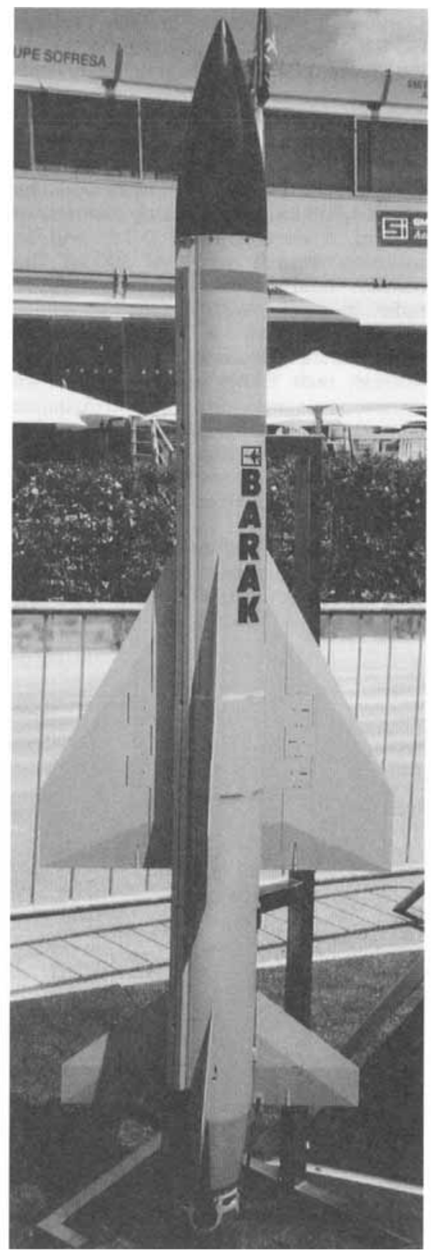
Description

The Barak 1 missile has four folding clipped-tip delta-wings and four folding moving clipped-tip control fins at the rear. The missile is 2.17 m long, has a body diameter of 0.17 m, an unfolded wing span of 0.68 m, and weighs 98 kg. In addition to the control fins, there are thrust deflectors



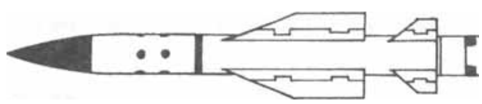
A rear end view of the Barak missile, showing the thrust deflectors in the boost motor exhaust nozzle

An engagement radar with EO tracker, the Elta STR, used with the Barak system on the Saar 4 FAC



A Barak surface-to-aii missile displayed at Paris in 1999
(Duncan Lennox) 2000/0079445

in the boost motor exhaust nozzle to assist in controlling the missile after its vertical launch. The boost motor section is ejected on completion of the initial boost phase. Guidance is by radar-controlled Command to Line Of Sight (CLOS), using an Elta STR M2221 coherent pulse-Doppler radar, or using an electro-optic tracker in severe ECM conditions. The STR engagement radar operates in the 8 to 40 GHz (X/Ka-bands), has an elevation coverage of +85 to −25° and a range of about 20 km. The Barak missile warhead weighs 22 kg, and is a fragmentation type with an active laser fuzing system that is supported by an altimeter to allow the interception of very low level targets. The missile has a range of 12 km against aircraft targets, and probably about 5 km against sea-skimming anti-ship missiles. A minimum range of 500 m is reported. The lightweight system including radar, fire-control system and eight missiles in launch canisters weighs a total of 3,000 kg. The fire-control radar can command two separate missiles towards each target and it is reported that the Barak system can be fully automatic under the control of the threat evaluation system.



A line diagram of the Barak missile

Operational status

Development started in 1983 but the Barak missile programme was funded at low level. Sea trials began in 1989 and the first Barak firing at sea was successfully carried out in 1991, with a successful interception of a Gabriel anti-ship missile in 1993. Barak 1 is reported to have entered service with the Israeli Navy in 1994. Missiles have been fitted to the 'Hetz' class Fast Attack Crafts (FACs), and to 'Eilat' class corvettes (Saar 5). Barak has been exported to Chile, to be fitted to four Prat class, former UK 'County' class destroyers, and to Singapore for its 'Victory' class corvettes. Singapore fired a small number of missiles during exercises in July 1999. Trials have also been reported from South Africa, with several Barak missile firings being made there in 1991. Venezuela ordered three mobile land-based systems in 1998, to be integrated with Flycatcher Mk 2 weapon systems for airfield defence. India ordered Barak missiles in November 2000 for fitting to the aircraft carrier INS Viraat, and may fit the missiles into Rajpat class (Kashin II type 61ME) destroyers and modified Godavari (type 16A) frigates.

Specifications

Length: 2.17 m
Body diameter: 0.17 m
Launch weight: 98 kg
Warhead: 22 kg HE fragmentation
Guidance: CLOS
Propulsion: Solid propellant
Range: 12 km

Associated radars
Engagement radar: Elta STR
Frequency: 8-40 GHz (X/Ka-band)
Peak power: n/k
Range: 20 km

Contractors

IAI, MBT Systems, Yahud, and Rafael, Haifa.

Arrow 2

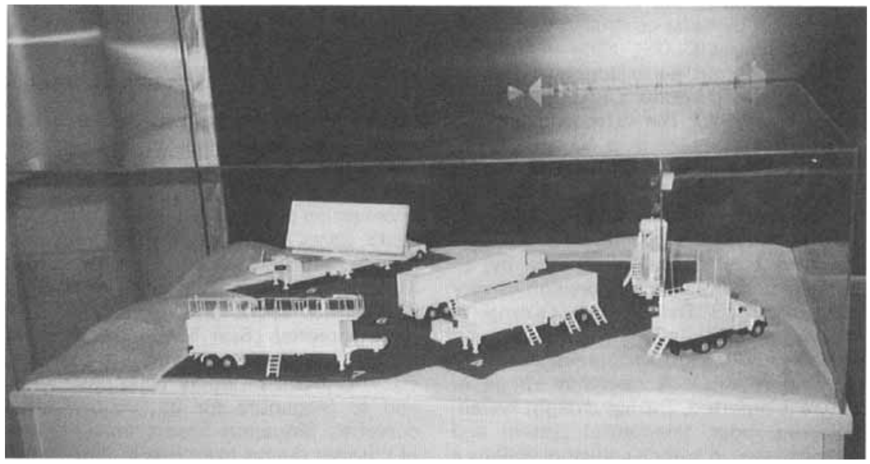
Type

Short-range, ground-based, solid propellant, theatre defence missile.

Development

The Arrow (Chetz) Anti-Tactical Ballistic Missile (ATBM) system was jointly funded as a technology demonstrator and development programme by Israel and the USA. The USA and Israel agreed to share the costs for development, procurement and operation up to 2010. This formed a part of the Israeli 'Homa' (Wall) project, to defend Israel against all missile attacks. The Arrow demonstration programme MoU was signed in June 1988 and the prime contractor was IAI, although it is reported that US companies have been involved in licensing agreements to provide supporting technologies to the programme including Lockheed Martin, and Amber Engineering (now Raytheon Missile Systems). The requirement was to demonstrate a theatre defence missile system capable of intercepting SS-1 'Scud', SS-21 'Scarab' SRBMs (Short-Range Ballistic Missiles) and hopefully also the longer range Iraqi Al Hussein, as well as the Chinese CSS-2 missiles deployed in Saudi Arabia. A follow-on programme, Arrow Continuation Experiments (ACES), was jointly funded by Israel and the USA to develop a smaller and less expensive missile system, and this missile is now known as Arrow 2. Arrow 2 has the capability to intercept ballistic missiles with ranges up to 1,500 km. The Arrow 2 Weapon System (AWS) is now completing development and the production programme is under way. Some reports have suggested that Arrow 2 may be capable of intercepting large aircraft and high-flying cruise missile targets, in addition to ballistic missiles, but this is denied by Israel. The missile, launcher and launch control centre are being developed by IAI MLM Division, a combined early warning and engagement radar is being developed by IAI Elta Division, with battle management and communications vehicles being developed by Tadiran Electronic Systems.

In 1997, it was reported that a follow-on Arrow programme is being planned, known as the Arrow System Improvement Programme (ASIP), to upgrade to Arrow 3 by about 2010. Arrow 3 is planned to be able to intercept ballistic missiles with ranges up to 2,500 km, and to be able to counter simple decoys and manoeuvring targets. An Arrow link 16 upgrade is being developed to enable the AWS to co-operate with US MIM-104 Patriot batteries, and a later programme will include US Aegis ships. A trial in 2000 is reported to have used US satellite early warning data as a cue to the AWS. Unconfirmed reports in April 1998 suggested that Israel and Turkey were discussing a possible collaborative programme to develop a new ATBM, with a range of 150 km, based on some Arrow technologies. In 2000/2001 discussions were held with several major USA companies to set-up a production facility for Arrow 2 in the USA, for export sales and to provide Israel with missiles through the US military aid programme.



A model of a proposed radar site for the Arrow system, including: rear left the radar antenna vehicle. front left the radar cooling vehicle, centre the radar power unit, right centre the fire-control centre, and on the right a communications vehicle and aerial tower (Duncan Lennox)

A view inside a Citron Tiee fire-control centre (Tadiran) **2001** 0104267

Targets for the Arrow trials programme have used converted single stage solid propellant Arrow missiles, designated TM-91, and the Black Sparrow. The Black Sparrow target is based on the Rafael designed AGM-142 air-to-surface missile already in service in Israel and the USA, and is launched at high altitude from an F-15 aircraft to simulate an incoming ballistic missile. This target has a range of around 300 km, and could carry either a single warhead, decoys or submunitions.

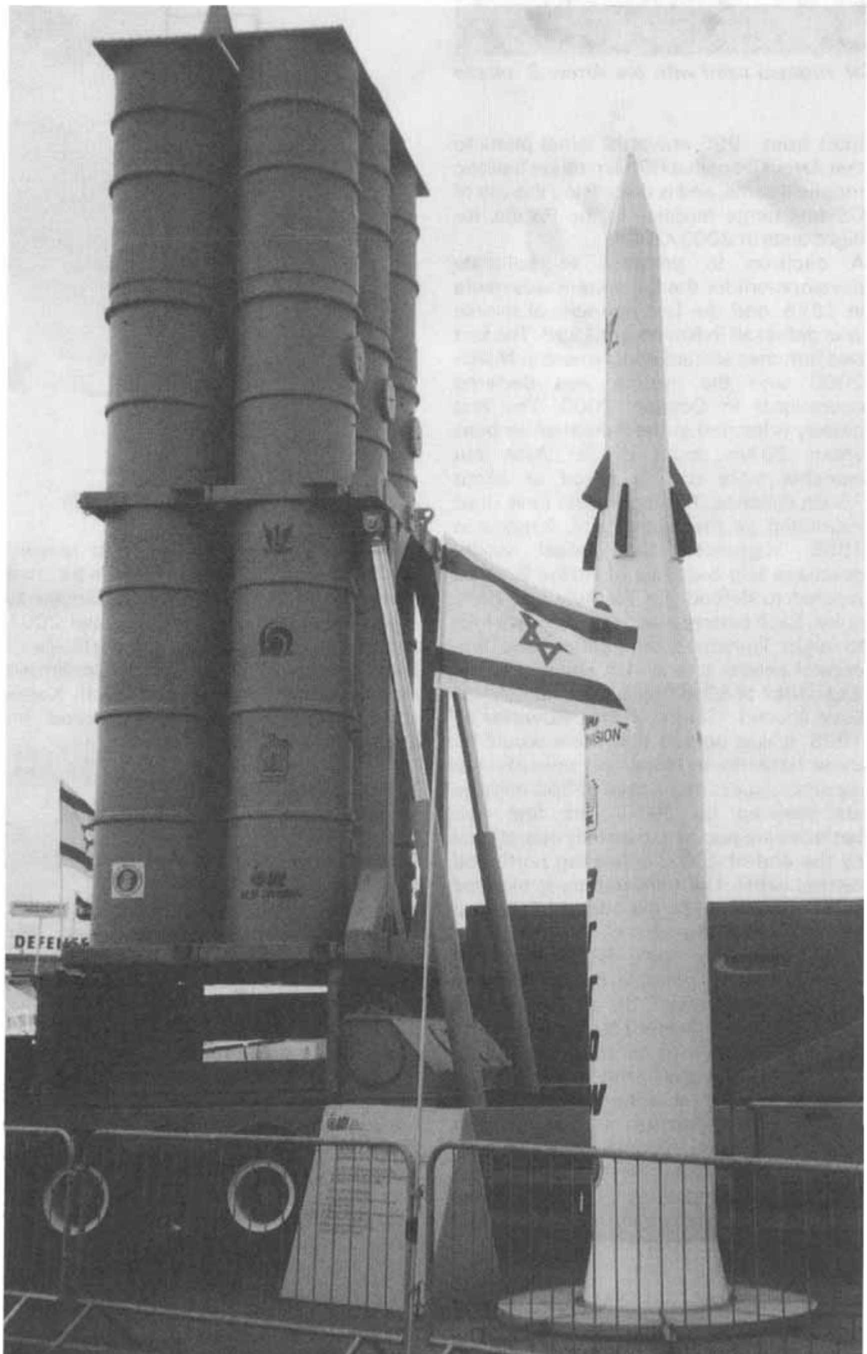
Description

The original Arrow 1 missile was a technology demonstrator, and was used for seven flight tests. Arrow 1 was a two-stage solid propellant missile, with an overall length of 7.5 m, a body diameter of 1.2 m and a launch weight of around 2,000 kg. It is estimated that the second-stage had a length of 2.5 m, and that Arrow 1 had inertial and command update mid-course guidance, with a terminal IR focal plane array. The missile has been described as being high-speed and very manoeuvrable, with thrust vector control in the boost and second-stage motor nozzles. The range was around 50 km. A focused proximity fuzed fragmentation warhead was reported to be under development for the Arrow 1.

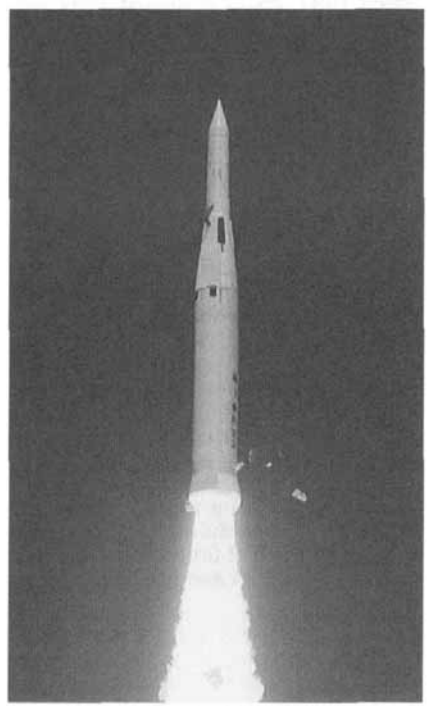
It is reported that Raytheon offered a derivative of the Pave Paws radar for surveillance, and also proposed integration of the Patriot AN-MPQ-53 radar. However, Israel decided that it would develop a radar, originally called MUSIC but now known as Green Pine, for the Arrow

system. IAI Elta was selected to develop an EL/M 2080 **3-D** phased array 500 to 1,000 MHz (L-band) dual-role surveillance/ engagement radar with a range of 500 km and providing a command up/down link to the missile.

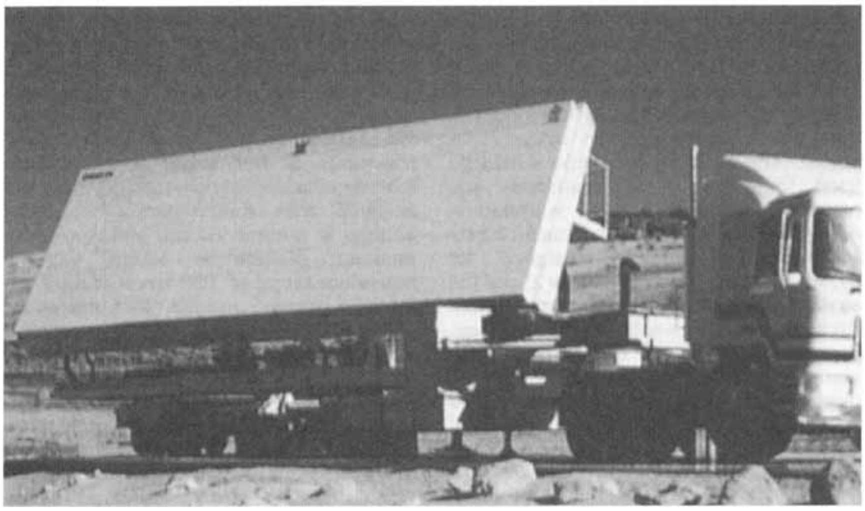
Arrow 2 is believed to be 6.95 m long, and to have a launch weight of 2,500 kg. The missile has two IMI Rocket Systems Division solid propellant stages, with both stages using TVC. The second-stage ignition can be delayed to provide a coasting period between the first and second stages, which would be used for low-altitude intercepts. The first stage is believed to be 3.45 m long with a diameter of 0.8 m, followed by a short sustainer motor assembly of 0.75 m length, with a kill vehicle that is 2.75 m long and weighs around 500 kg. The terminal seeker has a dual-mode indium antimonide focal plane array (imaging IR) seeker developed by Amber Engineering (part of Raytheon) in the USA, together with an active radar seeker. The active radar mode would be used for low-level engagements, and probably as a fuze for the warhead in head-on engagements. The focused blast/ fragmentation warhead designed for Arrow 1 has been used in Arrow 2, and the seeker directs the fuze towards the target. An active radar fuze is believed to be used, and this selects the quadrant for the warhead fragments depending on the direction of the target. The Arrow 2 kill vehicle contains the terminal seeker, warhead and fuze, and uses four moving delta aerodynamic control fins for lower altitude interceptions. The kill vehicle is designed to achieve a hit-to-kill interception, but if this is not achieved then the proximity fuze will direct the warhead fragments at the target shortly before reaching the closest point to the target. It is believed that the minimum intercept altitude is around 10 km, and maximum intercept altitude is 50 km, with a maximum range of 100 km. It is reported that the Arrow 2 missile has a maximum speed of 2.5 km/s. The missiles are carried on a IAI L3 towed trailer, with six missiles in their canisters raised to the vertical before launch. The missiles use a hot ejection method from the canisters, and **up** to three missiles can be fired at any one target. It takes one hour to reload the launch trailer with six missiles, and the launchers can be located up to 100 km from the Fire Control Centre (FCC). The Elta Green Pine L-band radar has an antenna vehicle, a power supply vehicle, a coolant vehicle and a communications vehicle. The antenna is 12 m long and 5 m high, providing both long-range surveillance and acting as an engagement radar. The Tadiran Fire-Control Centre (known as Citron Tree) provides battle management, integration with other defence systems, a pre-mission simulation capability and a post-mission analysis function. The FCC has 10 operator positions, can control up to 14 intercepts, and has link 16 (Tadil J) for interoperability with Patriot fire units. An IAI Launch Control Centre (LCC), known as Hazelnut Tree, is vehicle mounted and controls up to eight launcher vehicles, allocating the missiles as requested by the FCC. The LCC also contains a maintenance and training capability. Following a vertical launch an Arrow 2 missile turns in the direction of the target and accelerates with the first-stage boost motor. For long-range or low-altitude



An Arrow 2 missile beside the six canisters of a launch vehicle. displayed at Paris in 1999 (Duncan Lennox) *20001007*9444



*The first test launch of ACES. a demonstrator for **Arrow 2**, made in July 1995*(IAI)



The Green Pine surveillance/engagement radar antenna used with the Arrow 2 missile system (IAI)

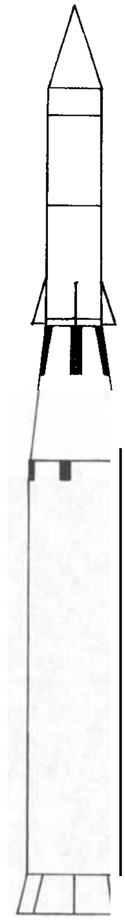
engagements this is followed by a coast period. The second stage sustainer motor then ignites, and the first stage assembly separates leaving the second stage approaching the target. After target acquisition by the kill vehicle's terminal seeker, the guidance directs the kill vehicle towards the intercept point, until there is a direct impact or the fuze detects the target and initiates the warhead.

Operational status

The first Arrow 1 flight test was made in August 1990, and the last of the seven flight demonstrator series was made in 1994. The first of three ACES development test flights was made in July 1995, with the third in 1996. This third flight was the first to result in a direct hit on a target vehicle, a modified Arrow 1 missile. The first Arrow 2 flight test, AST-1, was a successful intercept test and was made in March 1997. AST-2 in August 1997 was unsuccessful, and the Arrow 2 had to be destroyed. AST-3 in September 1998 integrated the complete Arrow system together, but there was no target and the missile was destroyed after 97 seconds of flight. AST-4 in November 1999 was the first test of the complete Arrow 2 system, and resulted in direct hit on a TM-91 ballistic missile target. The test fully integrated the radar, Fire Control Centre (FCC), launch control centre and communications with the Arrow 2 missile. This test was made against a target flying away from the launch site. AST-5 in September 2000 was made against a Black Sparrow target flying towards the launch site, simulating a 300 km range ballistic missile attack, and this test was successful achieving a direct hit. AST-6 in August 2001 was also against a Black Sparrow target flying towards Israel, and resulted in a successful intercept at a range of 100 km. The first Green Pine radar was completed in 1994 and has been used in trials from 1995 onwards. Israel plans to test Arrow 2 against 600 km range ballistic missile threats, and is discussing the use of US test range facilities in the Pacific, for flight tests in 2003/2004.

A decision to progress to full-scale development for the full system was made in 1995, and the first operational missile was delivered in November 1998. The first two batteries started deployment in March 2000, and the system was declared operational in October 2000. The first battery is located at the Palmahim air base about 20 km south of Tel Aviv, but launcher sites are dispersed at about 75 km distance. The flight tests have used Palmahim as the launch site. Reports in 1995 suggested that Israel would purchase two batteries of Arrow 2, to be located to defend the Tel Aviv and Haifa areas. Each battery is expected to have four to eight launchers, one radar, one fire-control centre, one launch control centre, and a total of 50 missiles. Each battery will have around 100 personnel. However, in 1998, it was agreed that there would be three batteries in Israel and unconfirmed reports suggest that a total of 350 missiles are planned by 2010. The first two batteries are planned to be fully operational by the end of 2002, defending north and central Israel. The third battery is planned to be operational by the end of 2005, and will defend southern Israel.

In 1999 there were discussions with Turkey about a possible export order or licensed production of an alternative missile based on Arrow 2 technologies, but any exports have to be approved by the USA due to the joint development programme. Israel also suggested the possible formation of a theatre wide defence system, co-ordinating ballistic missile defences over several countries in the region, including Turkey. These discussions continued through into 2001, including some production of Arrow 2 system components in Turkey. In January 2001 it was reported that India had ordered two long-range radars, similar to Green Pine radars, and in December 2001 that India was discussing the purchase of some Arrow 2 missiles. Unconfirmed reports indicate that Japan, South Korea and Taiwan, have also expressed an interest in the Arrow 2 system.



*A line diagram **of** the Arrow 2 missile*

Specifications

Arrow **2**
Length: 6.95 m
Body diameter: 0.8 m
Launch weight: 2,500 kg
Warhead: HE fragmentation
Guidance: Inertial, command and IIR/active radar
Propulsion: 2-stage solid propellant
Range: 100 km

Associated radars
Surveillance/Engagement radar: EL/M 2080 Green Pine
Frequency: 500-1,000 MHz (L-band)
Peak power: n/k
Range: 500 km

Contractor

IAI MLM Division. Beer Yakov.

Aspide (Albatros/Spada)

Type

Short-range, ground- and ship-based, solid propellant, theatre defence missile

A six-canister towed launcher vehicle for the Aramis/Aspide system, with a mast-mounted additional surveillance radar behind (Alenia) 0010169

Development

Development work started on the Aspide missile as a private venture in 1969 and was based on the US AIM-7 Sparrow airframe, modified with an Italian semi-active radar seeker It was intended as a replacement or an alternative for the Sea Sparrow missile used by the Italian Navy, and became known as the Albatros system. There were also three other variants developed. an air-to-air Aspide to replace the AIM-7E Sparrow; a ground-to-air variant, incorporated into the Contraves Skyguard as an alternative to the RIM-7E Sparrow and called Skyguard/Aspide; and a ground-to-air variant for use in a new Italian Air Force system called Spada. Flight trials of the Aspide Mk 1 missile began in 1974 and from the beginning of 1979, operational firings were carried out from Italian and foreign vessels equipped with the Albatros system The Aspide Mk 1 has since replaced Sparrow in the inventories of several navies. It is fitted to Italian Navy ships. specifically the 'Garibaldi' class aircraft carrier, 'Maestrale' class destroyers, 'Artigliere' (Lupo) class frigates and 'Minerva' class corvettes. The Skyguard/Aspide was successfully demonstrated in 1981 and was subsequently adopted by Spain, which already had the Skyguard/Sparrow system. It has since entered service with the Italian and Royal Thai armies. The Spada point defence missile system was developed to meet an Italian Air Force requirement for a low-level air defence system to defend their airbases and other key areas To reduce both development time and costs, it was decided to use components already proven in other applications. The Aspide Mk 1 from the naval Albatros air defence system was chosen as the missile and a modified version of the naval Alenia Orion 30X radar tracker was used as the Search and Interrogation Radar (SIR). Trials with the first Spada prototype were completed in 1977 and full technical and operational evaluations by the Italian Air Force took place during 1982 and 1983

In 1994, another land-based Aspide missile system was proposed, called Aramis. This system comprises a launch control post with a mast-mounted surveillance radar, a six cell launcher with integral engagement radar and reload missiles. The surveillance radar proposed was an ARGOS, with a range of 45 km. An active radar replacement seeker for the Aspide Mk 1 missile was under development from1985 and was initially called IDRA, but a lower cost variant known as Aspide Mk 2 was adopted in 1990. However, this was also terminated in 1996. In 1995, a further improved version was proposed, called Aspide 2000. This was an alternative to Aspide Mk 2, utilising the same semi-active radar seeker and warhead as Aspide Mk 1, but with a larger boost motor and increased range. This has been offered to the Italian Air Force as an upgrade to their Spada system, to be known as Spada 2000, and includes the ability to integrate other short-range air defence weapon systems, as well as being air mobile in C-130 Hercules aircraft. Aspide Mk 1 missiles can be modified to the Aspide 2000 standard, and used with modified existing systems.

Launch of an Aspide Mk 1 surface-to-air missile from an Albatros eight-cell ship defence launcher

Description

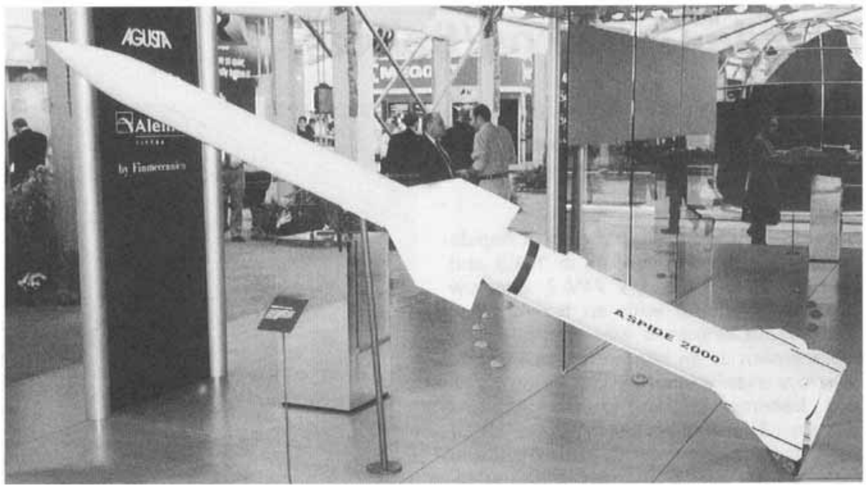
Aspide Mk 1 is similar in appearance to AIM-7 Sparrow, except that the wings and fins are clipped on the surface-to-air variant. The missile is 3.7 m long, has a body diameter of 0.20 m and weighs 220 kg at launch. It has a single-stage solid propellant motor and a 30 kg HE fragmentation warhead. The semi-active radar seeker uses CW monopulse techniquesfor ECCM and includes a Home-On-Jam (HOJ) capability. Unlike the AIM-7E. which uses an open-loop hydraulic power system, the Aspide's hydraulic and electrical power requirements are provided by a closed-loop system, allowing full hydraulic power throughout the missile flight.

The Aspide Mk 1 missile has a maximum range of 15 km, with an altitude for interception varying from 15 m to 6,000 m.

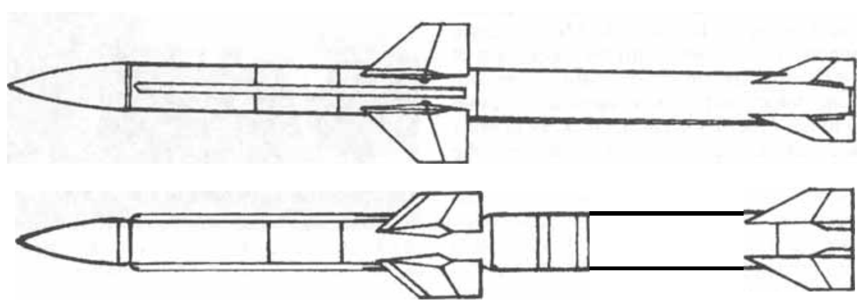
The Albatros ship defence system is designed to combat threats from aircraft and missiles, either sea-skimming or diving. It is a modular 'add on' SAM system

through which the missile system is integrated with the ship's gunnery radar fire-control system, avoiding the need for duplicating the tracking and illuminating sensors. In addition to being integrated with the principal current Alenia-Elsag radar fire-control systems (NA 21 and NA 30) and Hollandse Signaalapparaten (Mk 2 Mod 9). the Albatros system is also compatible with several other fire-control systems. One of the most widely used surveillance radars with the Albatros system is the Alenia Pluto RAN-10S. This is a high-power, combined air and surface search radar operating in S-band and is suitable for installation on medium tonnage ships such as destroyers, frigates and corvettes. The Alenia Orion RTN-30X pulse Doppler monopulse engagement radar used by the Albatros system was also adapted for use with Spada. It consists of an X-band tracking monopulse radar, a CW transmitter for target illumination and rear reference signal with a common circular dish-type antenna, which has a flat radome cover located on its own pedestal. On later versions of the radar, there is a TV sensor attached to the side of the radar antenna. The radar performs target acquisition, tracking and illumination for missile guidance. The TV set is used as a back up to the radar and as an aid for target identification and kill assessment.

An alternative engagement radar in general use with Albatros is the Signaal STIR (Signaal Track and Illuminating Radar). The radar functions in the same way as the Orion 30X, but the antenna is different in that it has a conical radome and comes in two sizes. STIR is available in three types, with magnetron or TWT transmitter and two antenna types (single cassegrain 1.8 or 2.4 m diameter). All STIR systems have a number of features, including integrated X-band CW illumination, a variety of MTI and ESM/ECM facilities, pilot tone injection for on-line boresight calibration and sector search capability (to search the jammed sector of a surveillance radar). The Albatros launching section comprises the launcher mounting and relevant control units. There are two versions of launcher fitted, the standard eight cell or the lightweight four canister. The Detection Centre (DC) of a ground-launched Spada battery consists of a Search and Interrogation Radar (SIR), which is a modified Alenia Pluto S-band radar system and a Tracking and Illuminating Radar (TIR) pulse Doppler radar, developed from the naval Alenia Orion RTN-30X X-band radar. The Aramis/Aspide system has a mast-mounted surveillance radar with up to four firing sections allocated to each detection centre. These normally consist of three, six-round launchers and can be up to 5 km from the detection centre. The mast-mounted surveillance radar has a range of 45 km, but the launcher units each have an autonomous surveillance radar with a range of 25 km, a CW illuminator radar with a range of 20 km and a TV camera in case of ECM. The Aramis/Aspide system can use either Aspide Mk 1 or Aspide 2000 missiles, and is reported to be C-130 Hercules transportable.



A model of an Aspide 2000 missile. exhibited in 1998 at Farnborough (Peter Humphris)
0044956



Line diagrams of the Aspide Mk 1 missile (top), and Aspide 2000 (bottom) 2002/0121a71

The Aspide 2000 missile has a length of 3.7 m, has a forebody diameter of 0.203 m, a rearbody diameter of 0.234 m and a launch weight of 225 kg. This missile uses the same semi-active radar seeker, warhead and control assembly as Aspide Mk 1, but has a larger solid propellant booster motor that increases the maximum missile range to 25 km. Aspide 2000 has improved ECCM capability. Aspide Mk 1 missiles can be modified to the Aspide 2000 build standard, and the Aspide 2000 missiles can be launched from modified Albatros, Spada and Skyguard systems. The Spanish Spada 2000 system has an upgraded Detection Centre, using a Thomson-CSF (now Thales) RAC 3-D surveillance radar with a range of 60 km, with a hydraulic mast that can elevate the antenna to 13 m. The Detection Centre has two operators, communications, GPS receivers, air conditioning and its own electrical power generation. A Spada 2000 battery has a Detection Centre, and two to four firing sections, with each firing section having an engagement radar and two missile launchers. Each launcher carries six missiles in their canisters.

Operational status

It is reported that over 4,000 Aspide Mk 1 missiles have been built. The Naval Albatros version entered service in 1978 and more than 100 systems have been produced for use with the Italian Navy as well as 12 other countries including: Argentina, Ecuador, Egypt, Iraq, Libya, Malaysia, Morocco, Nigeria, Peru, Thailand, Turkey and Venezuela. Brazil placed an order for six Albatros systems in 1995. The Skyguard ground-based system entered service with the Italian Army in 1983. It has also been exported to several countries including: Egypt, Greece and Spain (where it is called TOLEDO). The ground-based Spada system entered service with the Italian Air Force in 1984. In 1986, the Royal Thai Air Force ordered one complete Spada battery, which was delivered in 1988. The Aspide air-to-air variant entered service in Italy in 1988. Development of an active radar version started in 1985, and was known as IDRA, although by 1990 a lower cost active radar version, designated Aspide Mk 2, had replaced IDRA but was awaiting government funding. In 1995 Alenia proposed a semi-active radar Aspide 2000 version for use with the Spada ground-based system, and this was ordered by Spain with the first of two batteries delivered in late 1998. In 1999 the Italian Air Force were reported to be considering upgrading their Spada systems, but probably not to the same standard as the Spanish Spada 2000.

Specifications

Aspide Mk **1 (Albatros/Spada)**
Length: 3.7 m
Body diameter: 0.20 m
Launch weight: 220 kg
Warhead: 30 kg HE fragmentation
Guidance: Semi-active radar
Propulsion: Solid propellant
Range: 15 krn

Aspide 2000
Length: 3.7 m
Body diameter: 0.203 m and 0.234 m
Launch weight: 225 kg
Warhead: 30 kg HE fragmentation
Guidance: Semi-active radar
Propulsion: Solid propellant
Range: 25 krn

Associated radars
Surveillance radar: RAN 1*0S* Pluto
Frequency: 3-4 GHz (S-band)
Peak power: n/k
Range: 70 krn
Engagement radar: Orion RTN-30X
Frequency: 8-10 GHz (X-band)
Peak power: n/k
Range: 25 krn

Contractor

MBDA Missile Systems, Rome.

Tan-SAM (Type 81)

Type

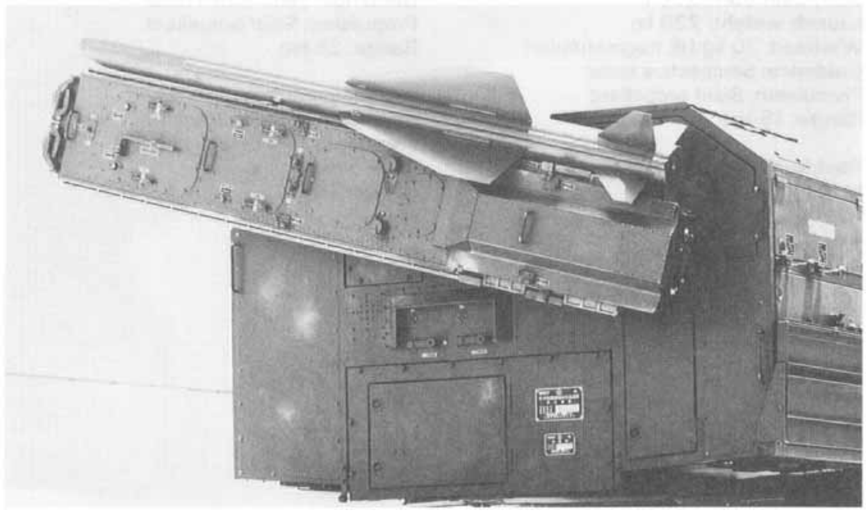
Short-range, ground-based, solid propellant, theatre defence missile.

Development

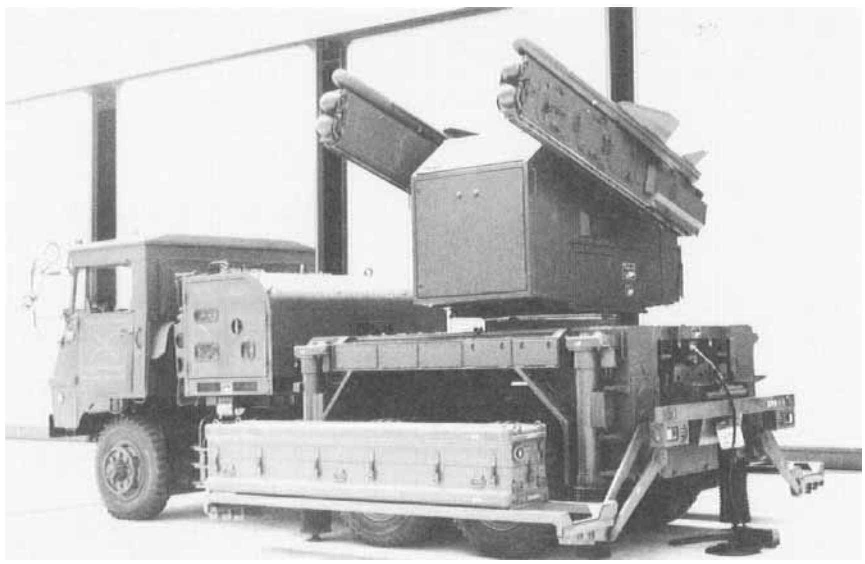
The Tan-SAM 1 ('Tan' meaning short range) missile, designated Type 81, was designed by the Toshiba Corporation as a mobile, lightweight, air defence missile system to destroy attacking low flying, high-speed aircraft. It was also a replacement anti-aircraft weapon for the Japanese Ground Self-Defence Force (JGSDF), to fill a performance gap between the US FIM-92 Stinger and MIM-23 HAWK surface-to-air missile systems. Tan-SAM 1 development started in 1966 and the first prototype was constructed between 1971 and 1976, with initial test firings starting in 1978. The JGSDF designated the Tan-SAM 1 as the Type 81 short-range surface-to-air missile system, and in 1980 they placed production contracts with Toshiba. The Type 81 missile became operational with the JGSDF in 1981. Design work on an upgraded version, known as Tan-SAM 1 kai, started in 1983 and a 5 year development contract was placed in 1989. Initial production started on upgrade kits in 1996. Development of an improved Tan-SAM 2 (Chu-SAM) was reported in October 1988, when Toshiba announced that it was developing a dual-mode active radar/IR seeker with mid-course update commands and a range of around 50 km (see Unclassified Projects).

Description

Tan-SAM 1 is similar in shape to the UK Rapier, except that the nose is rounded due to the use of an IR seeker. The missile has cruciform clipped delta-wings mid-body, with smaller in-line moving fins at the rear. Tan-SAM 1 is 2.7 m long, has a body diameter of 0.16 m and weighs 100 kg at launch. The warhead is of the HE fragmentation type, believed to weigh 9.0 kg and with contact and radar proxirnity fuzes. Guidance is inertial, with IR terminal homing believed to be with an all aspect capability. The motor is solid propellant, giving the missile a maximum speed of M 2.4. A fire unit comprises one Fire-Control System (FCS) vehicle, two quadruple round launcher vehicles and support vehicles, requiring a team of 15. Both the launcher and the FCS are mounted on the rear of a modified Isuzu Motors Type 73 (6 × 6) truck. The FCS consists of a 30 kW generator unit immediately aft of the driving cab, and the system control cabin to the rear. On top of the cabin is a 1 m wide, 1.2 m high, phased-array antenna. The radar's search range is reported to be around 30 km and an integral IFF interrogation facility is fitted. The radar itself is a multifunction, multi-target, three-dimensional pulse Doppler system with three basic modes of operation. In the omni-directional search mode, three-dimensional data is obtained by electronic vertical scanning of the radar beam and mechanical azimuth scanning of the antenna. In this mode, the antenna rotates at 10 rpm and sweeps 360" in



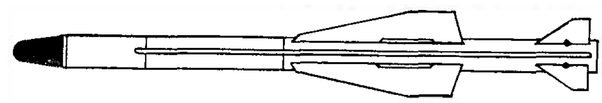
A Tan-SAM 1 (Type 81) missile on its launcher



A Tan-SAM 1 launcher vehicle with only the two upper missiles fitted (note optical tracker domes on front of the launchers)

A Tan-SAM 1 fire-control vehicle with the phased-array radar aerial iaised ready for use

azimuth and 15° in elevation during a full rotation. In a sector search/course track mode, the antenna does not rotate, but electronically sweeps 110° in azimuth and 20° in elevation. Range, azimuth and elevation information on up to six targets can be maintained in this mode and a computer is used to assess and display, on a CRT, the degree of threat from each target. On selection of the most threatening targets, the radar is switched to the fine tracking mode, in which more precise tracking data is obtained and the single-shot kill probability is displayed on the CRT and updated second by second. Two targets are selected for engagement and the location data for each is passed automatically, one to each of the two launcher systems. Each launcher slews and elevates the missiles towards its selected target and the missile's IR homing heads are activated. Once lock-on has been achieved, a programmed interception course is relayed to the missiles. On firing, the missile follows this initial course using an inertial reference until IR acquisition of the target is achieved. Once the IR homing head is locked on to the target, two more missiles can be selected and fired. In addition to the radar, each launcher is equipped with an optical director for use as a standby target designator if ECM or other difficulties rule out radar designation. The missile has a minimum range of 500 m, a maximum range *of* 10 krn, and can intercept targets at between 15 m and 3,000 m altitude.



A line diagram of the Tan-SAM 1 (Type 81) missile

The Tan-SAM 1 kai upgrade replaces the IR seeker with a phased array active radar seeker, adds a mid-course up-link from the engagement radar, and increases the maximum range to 14 km. It is believed that this upgrade was incorporated by modification to existing Tan-SAM 1 missiles, without a new build, and this increases the launch weight to 105 kg.

Operational status

Tan-SAM 1 (Type 81) entered service in 1981 with the Japanese Self-Defence Forces, and a total of 1,800 missiles have been built with 57 fire units for the Ground Self-Defence Force, 30 for the Air Self-Defence Force and 6 for the Maritime Self-Defence Force. An improved version, Tan-SAM 1 kai, has been developed and modification kits started production in 1996. Two fire units were planned for upgrade in 2000, indicating that the Tan-SAM kai programme is continuing.

Specifications

Tan-SAM **1**
Length: 2.7 m
Body diameter: 0.16 m
Launch weight: 100 kg
Warhead: 9 kg HE fragmentation
Guidance: Inertial and IR
Propulsion: Solid propellant
Range: 10 km

Tan-SAM **1** kai
Length: 2.7 m
Body diameter: 0.16 m
Launch weight: 105 kg
Warhead: 9 kg HE
Guidance: Inertial with updates and active radar
Propulsion: Solid propellant
Range: 14 km

Associated radars
Engagement radar: 3-D pulse Doppler phased-array
Frequency: n/k
Peak power: n/k
Range: 30 km

Contractor

Toshiba, Chiyoda-ku, Tokyo.

Chun-Ma (Pegasus)

Type
Short-range, mobile launched, solid propellant, theatre defence missile.

Development
In early 1986, it was revealed that the South Koreans were developing a self-propelled surface-to-air missile system called Chun-Ma (Pegasus), which included an indigenously developed missile. The system is also known as Korean-SAM (K-SAM). The weapon system is being developed by the Special Products Division of Daewoo Heavy Industries, in order to meet a South Korean Army requirement for a mobile all-weather SAM to protect its mechanised forces. Chun-Ma features a new full-tracked chassis developed by Daewoo, a Thomson-CSF (now Thales) turreted sensor system similar to that used with Crotale NG, and a missile developed by LG Precision. The electronic components and radars were developed by Samsung Electronics, now part of Thales. A longer range version, believed to be called KM-SAM, is now in development with an expected in-service date of 2008.

A Chun-Ma (Pegasus) tracked launch vehicle carrying out a missile firing (Daewoo Heavy Industries) 0097400

Description
The complete Chun-Ma SAM system consists of the full tracked vehicle, turret mounted sensor system, missile launching system and the missile. The missile is a short-range, Command to Line Of Sight (CLOS) surface-to-air missile powered by a solid propellant motor and armed with an HE fragmentation warhead. It is similar in appearance and size to missiles used in the Japanese Tan-SAM, UK Rapier, Israeli Barak and South African SAHV programmes, but is most probably based upon the VT-1 missile used by the French Crotale NG system. The Chun-Ma missile is cylindrical with a pointed conical nose, folding swept delta wings just aft of mid-body, and four folding clipped delta control fins at the rear. The missile is of modular construction and made up of the following five major sections. The nose section, which has a pointed nose cone and contains the guidance and control system. The warhead section with its associated safety and arming circuits, and an active laser fuze that has four pairs of in-line transmit/receive circular windows evenly spaced around the missile body. The solid propellant motor section to which the four wings are attached; and the tail section, which contains the control fin actuators, the CLOS receiver/transponder, and the exhaust nozzle for the motor.

The Chun-Ma missile is believed to be 2.17 m long, with a body diameter of 0.15 m and weighs around 70 kg at launch. Guidance is by radar or IR controlled CLOS. The 12 kg HE focused fragmentation warhead is activated by the active laser proximity fuze or contact fuze, and is reported to have a lethal radius of around 8 m. The missile is propelled from the launch tube by a solid propellant single stage motor, which accelerates the weapon to a maximum speed of M2.6. It is reported that the missile has a maximum effective range of 10 km and a manoeuvrability of up to 30 *g*.

The full-tracked chassis is of welded armour construction, providing the occupants with protection from small arms fire and shell splinters. The launcher vehicle is powered by a 520 hp diesel engine, with a maximum road speed of 60 km/h. The loaded vehicle weight is believed to be 25,000 kg. The launcher vehicle is NBC protected. The driver is seated front left, with the engine to the right. This leaves the rear two thirds of the vehicle clear for the missile fire-control system, which consists of the fire-control console, radar control console and the tracking radar cabinet. Mounted on top of the chassis is the power-operated unmanned turret, to which is mounted the sensor suite and eight missile canisters. High in the centre of the sensor package is the folding rectangular box type S-band (2-3 GHz) solid state pulse Doppler surveillance radar antenna. This radar is reported to have a range of 20 km and has a track-while-scan capability that can track up to eight targets at once with automatic threat evaluation. Mounted below the surveillance radar antenna is the circular dish antenna for the 8 to 12 GHz (X-band) engagement/tracking radar. This is reported to have a maximum range of 15 km. To the left of the tracking radar dish is the FLIR camera, which has two fields of view and a range of 15 km. On the right of the tracking radar dish is the daylight TV camera and the infra-red goniometer. Immediately after launch, the missile is gathered by the goniometer, which has a 10° field of view, and steered into the tracking radar's line of sight. The missile operator is provided with a full colour multi-window display console, and the system software allows Chun-Ma to be integrated with other battlefield and airfield defence assets and command systems. The Chun-Ma system will have the capability to engage a wide variety of targets under day and night conditions, out to a range of 10 km.

Line diagram of the Chon-Ma (Pegasus) missile 0097406

Operational status
Development started in 1989 with the building of two prototypes of the Chun-Ma SAM system. The first reported trials launch having taken place in March 1995. Low-rate initial production of six fire units started in 1996, and there were three reported tests made in 1997. It has been reported that the South Korean Army ordered 48 fire units with 140 missiles in December 1999, and that the system became operational in 2001.

Specifications

Length: 2.17 **m**
Body diameter: 0.15 **m**
Launch weight: 70 kg
Warhead: 12 kg **HE fragmentation**
Guidance: CLOS
Propulsion: Solid propellant
Range: 10 **km**

Associated radars
Surveillance radar: Thales
Frequency: 2-3 GHz **(S-band)**
Peak power: n/k
Range: 20 **km**

Engagement radar
Frequency: 8-12 GHz **(X-band)**
Peak power: n/k
Range: 15 km

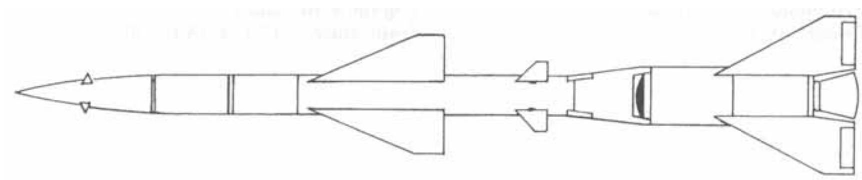
Contractor

Daewoo Heavy Industries, Inchon.

SA-2 'Guideline' (S-75 Dvina/Desna/Volkhov/Volga, V-750, V-755)

Type

Short-range, ground-based, solid and liquid propellant, theatre defence missile.



*A line diagram **of** the SA-2 'Guideline' missile*

Development

Development of the S-75 Dvina air defence missile system, designated SA-2 'Guideline' by NATO, started in 1953 at the Lavochkin OKB design bureau as a medium- to high-altitude SAM system for use against non-manoeuvring targets such as bombers. It was also designed to be more suitable for nationwide deployment than the R-113 or S-25 (SA-I 'Guild').

Reports indicate that other designators were used in Russia for this system, as upgrades were made over the years. The initial system, which became operational in 1957, was designated S-75 Dvina, and used a V-750 or V-750V missile. This version was designated SA-2A 'Guideline' by NATO. The weapon system had an engagement radar with the NATO designator 'Fan Song A. The second version, SA-2B. was designated SA-75 Desna, and used V-750VK or V-750VN missiles with a 'Fan Song B' radar. The third and fourth versions, SA-2C. were designated S-75M Volkhov, and used V-750M or V-750SM missiles with 'Fan Song C or D' radars. The fifth version, SA-2D, was designated S-75M Volkhov. and used the V-750AK missile with the 'Fan Song E' radar. The sixth version, SA-2E. was designated S-75M Volga and used the V-755 missile with the 'Fan Song F' radar. The seventh version, SA-2F. was designated S-75M3 Volkhov, and used the V-755 missile with the 'Fan Song E' radar. This system also had a RD-75 range-finding radar for use against jamming aircraft. On 1 May 1960, the Sverdiovsk units fired a total of 14 SA-2 missiles against a Lockheed u-2 high-altitude reconnaissance aircraft flown by Gary Powers. The subsequent detonation of the missiles at high altitude not onlyforced the U-2 to crash, but also destroyed a Soviet MiG-19 interceptor. The original V-750 missile (NATO designation SA-2A 'Guideline' Mod 0) was first shown in public during the 1957 Red Square parade in Moscow.

During 1967-68, following extensive combat experience gained on 'Guideline' during the Vietnam War and the loss of at least 12 SA-2B missiles with associated 'Fan Song B' radar equipment to Israel in the 1967 Six Day War, the V-75 system design bureau undertook a crash programme to improve the Electronic Counter-CounterMeasures (ECCM) capabilities and engagement envelope of the entire missile system. This improvement programme produced the sixth missile system in the series, the NATO designation SA-2E 'Guideline' and 'Fan Song F' radar. Prototype trials were undertaken in 1966, with the first production battalions being operationally deployed in 1968. A number of SA-2F systems were used by Egypt from 1975 onwards. Since 1980, the SA-2 'Guideline' system has been gradually replaced by the SA-IO 'Grumble' family and it is expected that only a few remain in service in the Russian Federation. However, the SA-2 system was exported to many countries, some systems have been upgraded during the 1990s. and it is expected to remain in service around the world for many years. In 1995 a digital electronic version was developed, using SA-IO 'Grumble' modules, with 12 digital assemblies replacing 78 analogue assemblies. This eighth version is known as S-75 Volga 2A, and uses an upgraded V-755 missile with a modernised 'Fan Song F' radar.

A nose view of an Iraqi SA-2F Guideline surface-to-air missile. taken in Baghdad in November 1988. showing a Fan Song engagement radar behind (Christopher F Foss)

In 1962, sea trials were carried out on a navalised version of the system. This was designated M-2 Dvina by the Soviets and SA-N-2 'Guideline' by NATO. These trials were conducted on the 'Sverdlov' class cruiser *Dzerzhinsky* in the Autumn of 1962. The system was apparently not successful, as it was never adapted to any other ship. Indeed, there is some question as to whether it was actually put to operational use after the sea trials.

China has developed a similar missile, designated HQ-2 (CSA-1); this missile system entered service in 1967 and has been exported to Albania, Iran, North Korea and Pakistan (see separate entry). Egypt built a version known as Morning Bird. Iran has developed its own version of SA-2, which it is believed to have entered service in 1998 as the Sawed-I. Iraq is reported to have increased the range of some of its SA-2 missiles to around 75 km, and these were used operationally in 1999. In 2001 Iraq added fibre optic datalinks, improved radars, and an IIR terminal seeker in the missile, to improve its capability against ECM and anti-radar missiles. These modifications are reported to have been assisted by Serbia and China.

There have been several reports of modified SA-2 'Guideline' missiles being used in the surface-to-surface mode, but it is not known which countries developed these modifications or if the same design changes were made in each country. There is no report of Russia using SA-2 as an SSM; but China, Iran, Iraq and North Korea may have built trials models. The Chinese project 8610 is reported to have developed a 150 km SSM from the Chinese variant of the SA-2 missile, the HQ-2. This SSM has been given the NATO designator CSS-8, and is described in the Offensive Weapons section. A modified SA-2 missile was being used in Russia during the 1990s as a ballistic missile target, named Strizh-3.

Description

The SA-2 is a two-stage missile with a large solid propellant jettisonable tandem booster stage, fitted with four large clipped delta stabilising fins. Towards the mid-section of the missile are four clipped delta-shaped wings with a second set of small

A P-15 'Flat Face' surveillance radar exhibitedin 7992 (Christopher F Foss)

An Iraqi SA-26 Guideline missile on its launcher at the Baghdad Exhibition in November 7988 (Christopher F Foss)

fixed-fins at the nose and a third in-line set of slightly larger moving control fins at the tail. The SA-2A/B/C models can be distinguished by the two sets of four, flush dielectric strip antennas in front and behind the forward fins.

The SA-2A is 10.6 m long, the diameter of the booster stage is 0.65 m, while that of the missile is 0.5 m. The launch weight with the 195 kg warhead is 2,287 kg. The missile has a maximum effective range of 30 km, a minimum range of 8 km and an intercept altitude envelope of between 450 and 25,000 m.

The SA-2B is slightly longer than the SA-2A at 10.8 m, but has the same body diameters, weight and warhead. This version has a reduced maximum range **of** 20 km, but the same minimum range and intercept altitude envelope.

The SA-2C has the same length, body diameters, weight and warhead as the SA-2B. The maximum range is extended to 39 km; the minimum range and maximum altitude stay the same, but the minimum altitude is reduced to 300 m.

The SA-2D differs significantly from the SA-2A/B/C in having four enlarged dielectric uplink guidance receiver strip antennas under prominent covers on the forward side of the missile, instead of the usual two sets of four on the nose. It also has a longer barometric nose probe and several other differences associated with the sustainer motor casing. The missile is 10.8 m long, has the same body diameters and warhead as the SA-2C, but the weight is increased to 2,450 kg. The effective maximum range is 43 km, the minimum range is 6 km and the intercept altitude envelope is between 250 and 25,000 m.

The SA-2E is characterised by a swelled bulbous warhead section and the absence of the forward fins. It is also believed there were several guidance modifications to improve the missile's ECCM capability and to match the new 'Fan Song F' radar. The SA-2E is 11.2 m long, has a body diameter

Two SA-2 'Guideline'surface-to-air missiles on display in Moscow, believed to be during the early 1960s (US Army)

Specifications

	SA-2A	SA-2B	SA-2C	SA-2D	SA-2E	SA-2F
Length	10.6 m	10.8 m	10.8 m	10.8 m	11.2 m	10.8 m
Body diameter	0.5 m	0.5 m	0.5 m	0.5 m	0.5 m	0.5 m
Launch weight	2,287 kg	2,287 kg	2,287 kg	2,450 kg	2,450 kg	2,287 kg
Warhead	195 kg HE Fragmentation	195 kg HE Fragmentation	195 kg HE Fragmentation	195 kg HE Fragmentation	295 kg HE or 25 kT nuclear	195 kg HE Fragmentation
Guidance	Command	Command	Command	Command	Command	Command
Propulsion	Liquid propellant with solid propellant booster					
Range	30 km	20 km	39 km	43 km	43 km	55 km

of 0.5 m and weighs 2,450 kg at launch. The missile can be fitted with either a command detonated 25 kT nuclear or 295 kg conventional HE warhead. It has the same range and altitude specifications as the SA-2D.

The last version, the SA-2F. had an improved guidance package to give it a Home-On-Jam (HOJ) capability. The missile is 10.8 m long, has a body diameter of 0.5 m and with its 195 kg warhead, weighs 2,287 kg at launch. The missile has a maximum range of 55 km, an effective minimum range of 7 km and the intercept altitude envelope is 100 m to 30 km.

The 195 kg warhead fitted to the SA-2A/B/C/D and F is an internally grooved fragmentation warhead, with proximity, contact and command fuzing available.

The complete SA-2 'Guideline' system comprises missiles, an early warning and acquisition radar, the 'Fan Song' engagement radar, fire-control system, six single rail launchers and ground equipment. Range, altitude and bearing of a target is passed by landline or radio to the 'Fan Song' engagement radar. The engagement radars 'Fan Song A/B/F′ are S-band radars (2 to 3 GHz), while the 'Fan Song C/D/E′ radars operate in C-band (4 to 6 GHz). When the missile is launched, its solid fuel booster burns for 4.5 seconds to take the weapon away from the launch site, after which it is jettisoned and the liquid fuel motor takes over. During the missile flight, the fire-control computer continues to receive data from the 'Fan Song' radar, which is now tracking both target and missile. The computer continually generates commands to guide the missile to the target and these are transmitted over a UHF radio beam datalink to four strip antennas (or eight depending on model), mounted forward and aft of the centrebody wings. The onboard guidance unit accepts these commands and adjusts the missile trajectory using the movable aft control fins. The liquid fuel sustainer motor burns for a total of 22 seconds with the SA-2 attaining a maximum velocity of about M3.5. Once guided to the vicinity of its target, the weapons fuzing system is activated and this detonates the warhead either by contact, proximity or command signal.

The NATO codename 'Fan Song' (given to the engagement radar) stems from the two fan-like radar beams projected from the system, together with the bird-like chirping sound of the radiation from the radar, which is audible to ELINT listeners. The basic elements of the radar are a pair of orthogonal 'trough' antennas, one horizontal and one vertical. The vertical antenna emits a fan-shaped beam, which scans from side to side and the horizontal antenna scans up and down. Both antenna beams cover a 10° arc and are about 2" wide, except for 'Fan Song C/E′ which are 7.5 by 1.5".

The 'Fan Song A' has two parabolic antenna, one fitted on top and in the centre of the horizontal antenna, while the other is attached to the end. This end parabolic antenna is used to transmit UHF guidance command signals to the missile. The 'Fan Song B and C′ models had the upper parabolic antenna removed, whereas the E model had two parabolic antennas added above the horizontal antenna to provide Lobe-On Receive-Only (LORO) mode. 'Fan Song E' has the Russian designator SNR-75M, and was augmented by a RD-75 radar operating at two different frequencies and with different polarisation to provide range on a jamming aircraft target. The LORO mode was removed on the 'Fan Song F' radar and replaced by a box-like structure.

Operational status

SA-2 'Guideline' is no longer in production in the Russian Federation, although it is possibly still in production in some other countries. The initial model SA-2A entered service in 1957 and the system formed the backbone of former Soviet strategic defence missile units during the 1960s and 1970s. with around 5,000 missiles in service. SA-2B entered service in 1959, SA-2C in 1961, SA-2D in 1966, SA-2E in 1968, and SA-2F in 1975.

Several countries built SA-2 missiles either under licence or as direct copies; China (missile designated HQ-2). North Korea, Egypt (missile called Morning Bird), and Iran (missile known as Sayyed-1). In 1992, it was reported that 2,400 SA-2 missiles remained in service in Russia with about 400 launchers, but it is believed that these have been replaced with SA-IO 'Grumble' systems and that by 2000 only a small number of systems remained in service. Only the SA-2E nuclear missile version was not exported, and various other variants are in service with the following countries: Afghanistan, Albania, Algeria, Angola, Azerbaijan, Belarus, Bulgaria, China, Cuba, Czech Republic, Egypt, Ethiopia, Georgia, Germany, Hungary, India, Iran, Iraq, Kazakhstan, North Korea, Libya, Mongolia, Pakistan, Peru, Poland, Romania, Slovakia, Somalia, Sudan, Syria, Ukraine, Vietnam, Yemen and Yugoslavia (Serbia and Montenegro). As well as the Gary Powers U-2 incident, the SA-2 SAM system has seen active service in many parts of the world.

The Chinese People's Liberation Army Air Defence Units shot down a Taiwanese-flown Lockheed U-2 over Narching in September 1962 and this incident was rapidly followed by the 1962 Cuban missile crisis, during which a US Air Force U-2 was lost in October 1962, to an SA-2 while flying over the Cuban naval base at Banes.

In mid-I965, the 'Guideline' was introduced into the North Vietnamese Air Defence Network, claiming its first victim, a US Air Force F-4C Phantom on 24 July that year. By the end of 1965, 194 SA-2s had been fired to destroy 11 US aircraft. The SA-2 'Guideline' also saw operational service with the Indian Air Force in 1963, with Egypt and Syria in 1967 and 1973, with Libya in 1986 and was used by Angola against the South African Air Force in the 1980s. Reports in 1994 indicated that a small number of SA-2 missiles had been launched in the former Yugoslavia as surface-to-surface missiles, and in 1999 it was reported that improved range SA-2 missiles were fired by Iraq at US aircraft patrolling the no-fly zones.

Associated radars
Surveillance radars: P-12 'Spoon Rest A
Frequency: 147-161 MHz (VHF)
Peak power: 350 kW
Range: 275 km

P-15 'Flat Face'
Frequency: 810-950 MHz (L-band)
Peak power: 400 kW
Range: 250 km

Height-finding radar: PRV-11 'Side Net'
Frequency: 2.56-2.7 1 GHz (S-band)
Peak power: n/k
Range: 180 km

Engagement radars: 'Fan Song A/B/F′
Frequency: 3 GHz (S-band)
Peak power: 600 kW
Range: 60 km

'Fan Song C/D/E′
Frequency: 5 GHz (C-band)
Peak power: 1,500 kW
Range: 75 km

Contractor

SA-2 'Guideline' was designed by the Lavochkin OKB, with assistance from the Grushin OKB. Support for SA-2 systems is now provided by Almaz NPO, Moscow and Fakel MKB, Khimky.

SA-3 'Goa' (S-125/4K90 Neva/Pechora)

Type

Short-range, ground-based, solid propellant, theatre defence missile

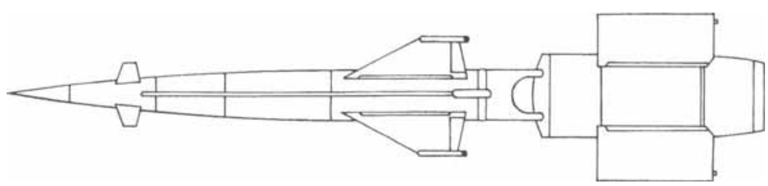
Development

Development of the former Soviet S-125 Neva air defence missile system, designated SA-3 'Goa' by NATO, began around 1956, at the Lavochkin OKB design bureau Itwas designed to complement the SA-2 'Guideline' at low- to medium-altitudes and is considered by some to be a counterpart to the US MIM-23 HAWK system The design of the SA-3's command-guidance system benefited greatly from earlier work on the SA-2, and the SA-3 system closely paralleled the SA-2D 'Guideline' Mod 3 with its associated 'Fan Song E' engagement radar The propulsion system was the first Russian air defence missile to use solid propellant motors in both boost and sustain stages It would seem that the former USSR had several codenames for the programme 'Neva' or M-1 appears to refer to the basic S-125 svstem (4K90), while 'Pechora' refers to the S-125 export system with some missiles designated 5V24 (V-600) and 5V27 (V-601). The missile may have also been given its own codename, 'Volna'. All of these names refer to Russian rivers. Prototype trials began in 1959, with initial deployment beginning in 1961 at static sites on trainable twin launchers. The SA-3 'Goa' system entered operational service later that year with the PVO-Strany missile units for use in airfield defence, low-level air defence around long-range SAM systems and the rear area protection of Army fronts in conjunction with the SA-2 'Guideline' system.

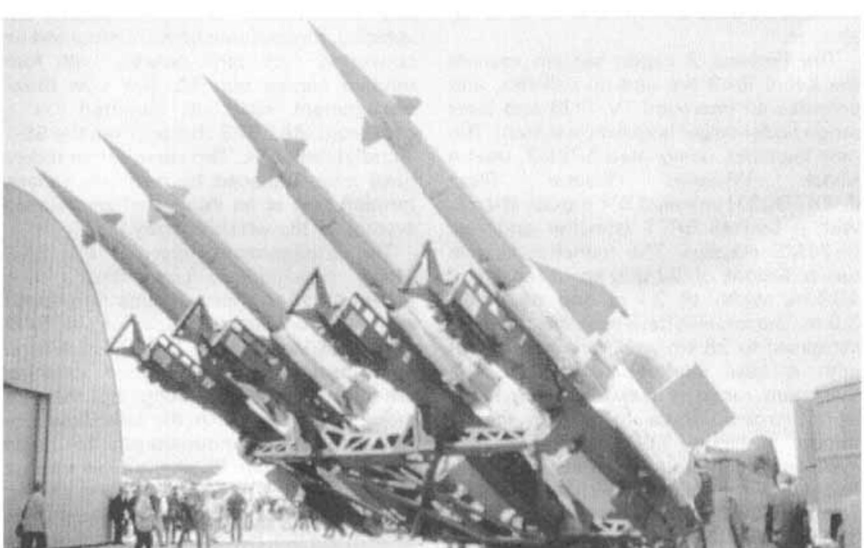
Two SA-3 missiles on a Pechora 2 mobile-wheeled launcher vehicle (Peter Felstead)
2001/0104268

At the same time as the SA-3 'Goa' entered service, a navalised version, S-125M/Volga-M, achieved operational status with the Russian Navy aboard cruisers and destroyers. The S-125M-1 was later called the SA-N-1 'Goa' under the NATO designation system. The initial version of the missile, the SA-3A'Goa' Mod 0, was the basic model of the system. It was followed in 1964 by the improved SA-36 'Goa' Mod 1, which had a shorter minimum range, improved low altitude performance and slightly greater maximum altitude. The original model of the system employed a two-rail, semi-static launcher. This could fire either the SA-3A or SA-36 missile. Around 1970, the 5P73 four-rail launcher was introduced. The development of the four-rail 5P73 launcher was prompted by the experiences of PVO troops in Vietnam. Earlier estimations of missile kill probability (a very optimistic 50 per cent) had proved wrong. Missile expenditure was higher than anticipated and missile reloading had created unacceptable delays. There have been reports of a version of the SA-3 'Goa' missile with additional terminal homing, but this has never been confirmed. In 1993, a modernised SA-3C version, the export Pechora-M, was offered with the introduction of digital signal processing, improved radar, less maintenance and an increased range.

In 1998, a Pechora 2 missile system upgrade was being offered for export by the Russian-Belarus Defence Systems Group, a consortium of companies including Almaz and Fakel. The Pechora 2 system has the entire fire unit mounted on wheeled vehicles, increased range for the missiles, improved lethality and ECCM, and reduced maintenance requirements. The tracking time has been reduced from 8 to 3 seconds. Some 44 analogue units have been replaced by 6 digital units, and interfaces added to allow data inputs from external surveillance radars. Automatic target acquisition using improved electro-optical sensors is an additional option. The first Pechora 2 system tests started in 1999. Poland has upgraded some SA-3 fire

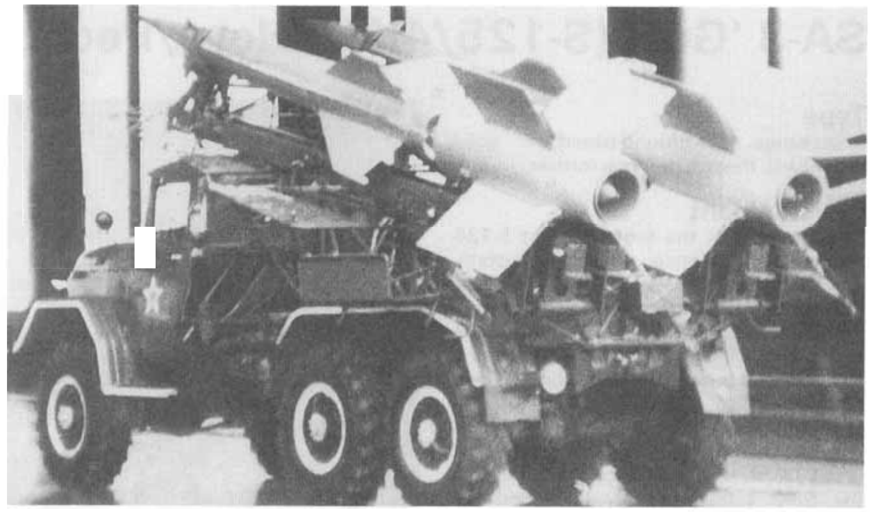


A line diagram of the SA-3 'Goa' missile *00*10165



Four SA-3 'Goa' missiles fitted to a four-rail launcher, exhibited in Moscow in 1999 (Peter Felstead)
2001/0104269

A 'Flat Face' P-15 surveillance radar antenna and van



Two early SA-3A 'Goa' missiles. showing the rear boost inotor assemblies 200010079441

units with modern digital electronics and by mounting the launcher assembly on converted T-55 tank chassis. The 'Low Blow' engagement radar has been mounted on a converted SS-1 'Scud' TEL chassis, the MAZ 543 vehicle.

Description

The SA-3 missile is a two-stage weapon with a large solid propellant jettisonable tandem booster, fitted with four large rectangular stabilising fins. One of the unusual features of the design is the configuration of these booster fins. Prior to launch, the fins are folded forward with the leading edge against the booster casing. At launch, they pivot back through 90° and then lock back for flight. The main body is cylindrical in shape with four clipped, delta-shaped wings with antennas (command and beacon) on the tips aft of mid-point, four small clipped delta moving control fins well forward on the nose taper and four rectangular fins at the rear. The overall length of the missile is 6.1 m, the diameter of the booster stage is 0.55 m and that of the missile proper is 0.37 m. The weight of the SA-3A at launch is 946 kg, whereas the 3B is slightly heavier at 950 kg. Both versions have the same 60 kg HE fragmentation warhead with Doppler radar proximity and contact fuzes. The complete SA-3 'Goa' system comprises missiles, the early warning and acquisition (surveillance) radar, the heightfinder radar, the 'Low Blow' engagement radar, fire control system, four twin 5P73 quadruple launchers and ground equipment.

When the missile is launched, the solid propellant booster burns for 2.6 seconds and is then jettisoned. The 19 second burn solid propellant sustainer motor takes over, accelerating the missile to M3.5. The SA-3A had a maximum range of 22 km, while the improved low-level performance of the SA-3B versions resulted in a shorter maximum range of 18 km. The minimum range of the SA-3A was 6 km, and this was reduced to 2.5 km for the SA-3B version. SA-3A has a maximum intercept altitude of 12 km and a minimum of 1.5 km. SA-3B has a maximum intercept altitude of 18 km and a minimum of 50 m. During the missile flight, the fire-control computer continues to receive data from the 'Low Blow' radar, which is now tracking both target and missile. The computer continually generates commands to guide the missile at the target and these are transmitted over a UHF radio beam datalink to the rear-wingtip antennas. The onboard guidance unit accepts these and adjusts the missile trajectory using the four forward control fins. The warhead is armed after the missile has travelled 50 m, with the Doppler radar fuze being activated by command signal when the missile is 300 m from the launcher. If the missile fails to intercept, another signal is sent to either change the trajectory or self-destruct. Against F-4 fighter aircraft sized targets at low level, the 60 kg HE fragmentation warhead has a lethal burst radius of 12.5 m. The quadruple launcher is reported to have a reload time of 50 minutes.

SA-3C 'Goa' (Pechora-M) has introduced digital signal processing to improve the radar accuracy and resistance to Electronic CounterMeasures (ECM), to automate the command link and to improve missile control. The maintenance workload has been halved and the kill probability improved. The minimum range of SA-3C is 3.5 km. the maximum range is 25 km, with intercepts possible from 20 m up to 18 km altitude.

The Pechora 2 export system mounts the entire SA-3 fire unit on vehicles, and provides an improved TV, FLIR and laser range-finder target acquisition system. The new launcher, designated 5P73-2, uses a Minsk Wheeled Tractor Plant (MZKT-8021) wheeled 6 × 6 truck chassis with a two-rail 5P71 launcher and two 5V27ME missiles. The launcher vehicle has a weight of 32,000 kg, a length of 13.5 m, width of 3.2 m and height of 3.8 m. The missiles have a maximum range increased to 28 km, and have been fitted with a new warhead and fuze. The maximum range is reduced against low flying targets, down to 20 km against targets at below 1,000 m altitude. The intercept altitude capability of the Pechora 2 system is from 20 m to 20 km. The Casta 2 surveillance radar, designated 39N6E, is an upgraded digital version of the 250 to 500 MHz (UHF) radar P-15 'Flat Face' mounted on a Kamaz 4320 vehicle. This radar can be extended on a tower up to a height of 50 m, and can track 50 targets out to a range of 150 km. The 'Low Blow' engagement radar is mounted on a UNN-2M (MZKT-80211) vehicle, which weighs 23,000 kg, has a length of 10.8 m, width of 4.0 m, and height of 4.0 m. The radar antenna can be raised on a mast, together with TV and IRST sensors for use in ECM. A Command and Control Post is mounted on a UNK-2M (MZKT-8022) vehicle, which weighs 16,000 kg, has a length of 10.2 m, width of 2.8 m and a height of 3.8 m. The C2 vehicle has four operator positions, can receive target data from other radars, has a GPS/Glonass positioning system and datalinks to the launchers. The engagement radar and C2 vehicle can be located up to 10 km from the launchers. The Pechora 2 fire-control system can track 16 targets and control one intercept. It is believed that each fire unit will have four launch vehicles, two engagement radars, a command and control vehicle and a surveillance radar with its associated power generator and processing/control vehicles.

A Polish upgrade, known as Neva-SC, introduces locally designed digital electronics to improve the performance and reduce the maintenance costs, and also mounts the fire unit systems on vehicles. Missile launchers are mounted on converted T-55 tank chassis, with four missiles carried per TEL. The 'Low Blow' engagement radar is mounted on a converted MAZ 543 chassis, from the SS-1 'Scud' missile TEL. The surveillance radars have been replaced by new 3-D radars, forming part of an integrated air defence system for the whole country.

The engagement radar for the SA-3 'Goa', codenamed 'Low Blow', was patterned after improvements introduced into the 'Fan Song E' radar of the SA-2 'Guideline Mod 3'. The 'Low Blow' X-band radar uses two trough-shaped scanning antennas like the 'Fan Song', but they are mounted differently. On the 'Low Blow', the two antennas are mounted at a 45" angle in an upside down 'V' shape. This change was introduced to reduce ground clutter. These antennas generate saw-tooth fan beams, like the 'Fan Song'. Inserted into the top of the inverted 'V' is the square parabolic guidance command antenna. Between the two trough-shaped scanning antennas is a Lobe-On-Receive-Only (LORO) mode antenna. When the 'trough'

antennas acquire a target, the system can be switched to the LORO mode, transmitting from this central parabolic dish antenna. The target-tracking antennas scan in 6" swathes, providing a 12° radiated beamwidth. The 'Low Blow', has a track-while-scan capability and can simultaneously track up to six targets and guide two missiles to the same target, out to a range of 80 km.

For operating in a heavy ECM environment, late production 'Low Blow' radars have been fitted with 25 km range TV cameras to give the fire-control team the same data as from the radar, and allow a command interception to be carried out. Long-range, early warning and target acquisition is usually handled by a van-mounted P-15, L-band 250 km range radar with two stacked elliptical parabolic antennas. This has been designated 'Flat Face' by NATO. In some SA-3 battalions, the P-15 has been replaced by the P-15M radar set, designated 'Squat Eye' by NATO. This has a similar performance but has had its antenna mounted on a 30 m mast to improve the low altitude coverage. A PRV-11, 180 km range, 32,000 m altitude S-band heightfinder radar, designated 'Side Net' by NATO, is also used with the SA-3 'Goa' system.

Two SA-3A missiles oti the Goa system s transloader vehicle (US Army)

Operational status

The initial model SA-3A 'Goa' Mod 0 entered service in 1961. This was followed in 1964 by the improved version, SA-3B 'Goa' Mod 1. In late 1986, it was reported that the former Soviet Union still had over 300 SA-3 battalion sites in operation using either four twin or 5P73 quadruple rail launchers. It is understood, however, that by 1995, the number of these sites had been reduced to around 100. The export SA-3C was announced in 1993, and it is believed that several fire units have been upgraded to this standard.

The Pechora 2 export system upgrade was ordered by Egypt in 1998, with up to 50 fire units to be improved by a Russian Federation consortium between 2001 and 2004. The first flight tests of Pechora 2 were made in 1999, and a long-range test was made in November 2001. The SA-3 'Goa' system is believed to have completed production and has been exported to the following countries: Afghanistan, Algeria, Angola, Azerbaijan, Belarus, Bulgaria, Cuba, Czech Republic, Egypt, Ethiopia, Finland, Georgia, Germany, Hungary, India, Iraq, Kazakhstan, North Korea, Laos, Libya, Mali, Mozambique, Peru, Poland, Slovakia, Somalia, Syria, Tanzania, Ukraine, Vietnam, Yemen, Yugoslavia (Serbia and Montenegro) and Zambia. The major users were Egypt, India and Libya (60 systems each), Vietnam (50). Iraq (30). Syria (24). Cuba (12) and Peru (11 systems).

The SA-3 SAM system has seen active service in many parts of the world. The first recorded combat use was in 1970 when Soviet PVO-Strany units, including several 'Goa' missile regiments, were deployed to Egypt (to form a joint air defence network to cover the Suez Canal Zone during the last phase of the 1968 to 1970 Egyptian/Israeli War) where they shot down three F-4E Phantoms in four days. The next combat use came in late 1972, when the North Vietnamese used small numbers of SA-3s against US aircraft during the Linebacker raids. The first reported kill was also against the F-4 Phantom. However, the major combat test came during the 1973 Yom Kippur War, when both Syria and Egypt used large numbers against the Israeli Air Force. During this conflict, the Arab Air Defence networks of both fronts fired around 2,100 missiles of the SA-2/SA-3 and SA-6 types to destroy some 46 Israeli aircraft as confirmed kills. However, in return the Egyptians lost a number of SA-2/SA-3 and SA-6 batteries which were captured intact by the Israelis. Since 1973, the SA-3 has been used in combat by Iraq (1980 to 88, 1991 and 1996 to 2002). Syria in 1982, Libya in 1986, Angola in 1987, and Serbia in 1999.

Specifications

SA-3A

Length: 6.1 m
Body diameter: 0.37 m (booster 0.55 m)
Launch weight: 946 kg
Warhead: 60 kg HE fragmentation
Guidance: Command
Propulsion: Solid propellant
Range: 22 km

SA-3B/C

Length: 6.1 m
Body diameter: 0.37 (booster 0.55 m)
Launch weight: 950 kg
Warhead: 60 kg HE fragmentation
Guidance: Command
Propulsion: Solid propellant
Range: 18 km (B), 25 km (C), 28 km (Pechora 2)

Associated radars
Surveillance radars: P-15 'Flat Face'
Frequency: 810-950 MHz (L-band)
Peak power: 500 kW
Range: 250 km

P-15M 'Squat Eye'
Frequency: 810-950 MHz (L-band)
Peak power: 500 kW
Range: 200 km

Height-finding radar: PRV-11 'Side Net'
Frequency: 2.5-2.7 GHz (S-band)
Peak power: n/k
Range: 180 km

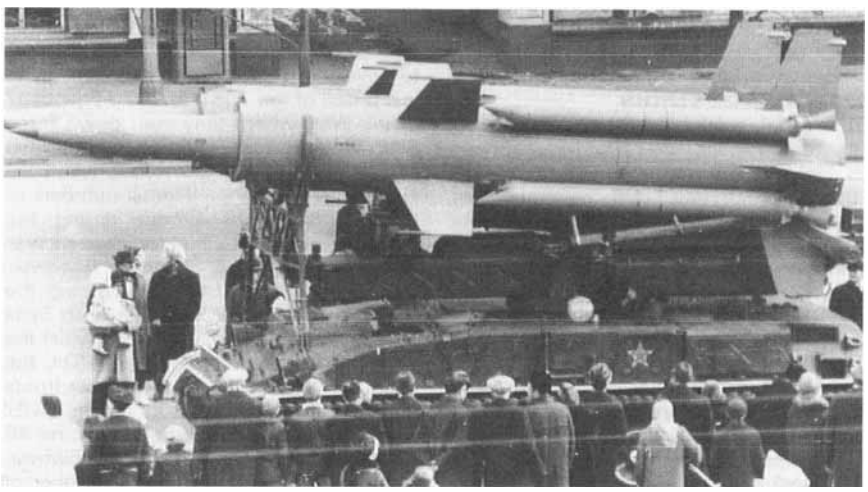
Engagement radar: 'Low Blow'
Frequency: 8.9-9.46 GHz (X-band)
Peak power: 250 kW
Range: 80 km

Contractors

SA-3 'Goa' was designed by the Lavochkin OKB with assistance from the Grushin OKB. Support for SA-3 is being given by Almaz NPO. Moscow and Fakel MKB, Khimky.

SA-4 'Ganef' (3M8/9M8 – Krug)

Long Nose SA-4A Mod Os beiiig installed on tfie tracked launcher with the reload vehicles onboard crane



SA-4 'Ganef missiles on display in Moscow, believed to be in the earlv 1970s

Type

Short-range, ground-based, ramjet-powered, theatre defence missile.

Development

Development of the SA-4 'Ganef' ZRK-SD 2K11 Krug began around 1957, and the system is believed to have been designed by the Lyulev OKB. The Krug was to be the first mobile air defence system to be deployed by the Soviet Army and the aim was to develop a medium- to high-altitude system to replace the rather cumbersome SA-2 'Guideline'. ZRK-SD Krug was first seen in public during a parade in Moscow in May 1964 and was given the NATO designation SA-4 'Ganef'. The system is based on the ZUR 3M8 missile, on which initial tests began in 1962 and the first trials unit was formed in 1966. Limited operational deployment began in 1967, but due to a number of problems, it was not fully operational until 1969.

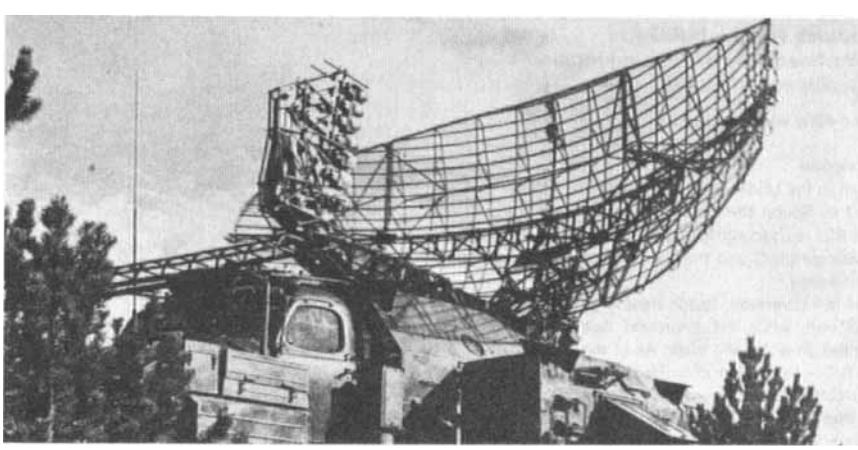
There have been at least four versions of the SA-4 missile; the 3M8 (later 9M8), 9M8M, the 9M8M1 and the 9M8M2. The first three types are externally identical and are designated SA-4A 'Ganef' Mod 0 under the NATO system. The 9M8M2 missile, designated SA-4B 'Ganef' Mod 1, appeared in 1973 and has a distinctively shorter nose. The SA-4B missile has improved low level performance and a reduced dead zone above the missile launcher, at the expense of range and a reduced maximum altitude. Reports suggest that batteries mix long and short nose versions, in order to make the most of their respective capabilities. A target drone, developed from obsolete SA-4 missiles, was proposed for export in 1994.

Description

The SA-4 'Ganef' missile is rather ungainly in appearance in that, for over two thirds of its length, it has a large diameter body, with the front nose section forming the inlet centre-body of the ramjet air inlet. SA-4 has four slender solid propellant rocket strap-on boosters with canted nozzles, and a ramjet sustainer motor. At mid-body, there are four moving clipped delta control-wings with antennas fitted to the tips. At the tail, there are four fixed, in-line, clipped delta fins. The SA-4A missile is 8.8 m long, has a main body diameter of 0.86 m and a launch weight of 2,500 kg. The SA-4B is shorter at 8.4 m, but has the same body diameter and launch weight.

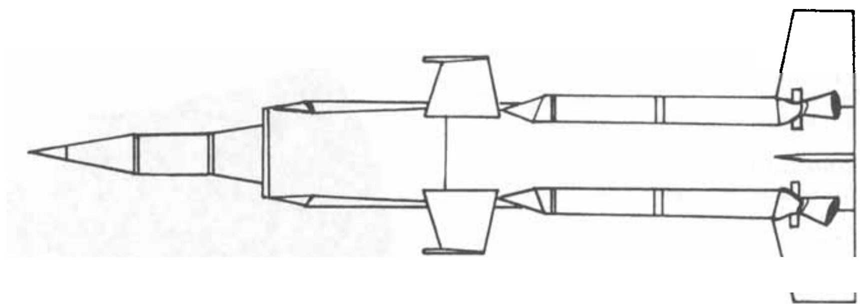
Both missiles use the same 135 kg HE fragmentation warhead, which is detonated by command or proximity fuzing. Guidance during mid-course is by a UHF radio-command datalink. A transponder is located on one of the tail fins to ensure positive tracking of the missile during the mid-course guidance phase. The terminal phase guidance is by semi-active CW radar homing, the reflected radar signal from the target being received by the four wing-tip antennas. The missile is launched using the four solid-fuel booster rockets, with a burn time of 15 seconds. The boosters are then jettisoned and the ramjet sustainer motor takes over.

The 'Ganef' system consists of missiles, the 2P24 SPU tracked mobile, two missile launcher, the 1S-32M 6.44-6.88 GHz (C-band) 'Pat Hand' mobile missile engagement radar and the 2T6 Ural-375 transporter/loader vehicle. It also uses, but not exclusively, the multipurpose 1S-12 'Long Track' 2 to 3 GHz (S-band) acquisition radar and the 'Thin Skin' 6 to 8 GHz (C-band) height-finding radar which are deployed at the brigade level. The SA-4 system can be operational within five minutes from arrival at a new site. A typical target engagement is believed to take place as follows: the target is first detected at long range by the 150 km range and



A Long Track' S-band surveillance radar, used witfi the SA-4 'Ganef missile system

30,000 m maximum altitude 'Long Track' early warning radar (also used for SA-6 'Gainful'). Height information is provided by the 240 km range 'Thin Skin' truck- or trailer-mounted height finding radar. Once in range, a single missile is launched and guided to the target, command-guidance with a semi-active terminal homing phase, although it is believed that two missiles can be guided to the same target. An electro-optical fire-control system is believed to be fitted for use in a heavy ECM environment. The SA-4A has range limits of 8 to 55 km and an altitude engagement envelope of between 100 m and 25 km. The SA-4B has a maximum range of 50 km, a minimum of 7 km and an altitude engagement envelope between 150 m and 24.5 km. The 'Long Track' and 'Thin Skin' radars pass target information to the SA-4 'Ganef' battery, where the C-band 'Pat Hand' CW engagement radar, transponder tracker and command-guidance link takes over.



A line diagram of an SA-4 'Ganef' missile

Operational status

Although the SA-4 'Ganef' Mod 0 was first seen in public in 1964, it did not enter operational service until 1967. The later version (Mod 1) entered service in 1973. At peak strength in the early 1980s. the SA-4 could have equipped as many as 50 air defence brigades. This amounted to 1,375 2P24 SPU launch vehicles and about 450 'Pat Hand' engagement radar vehicles. In view of the number of systems still in service, it seems likely that a modest level of production may have continued until the early 1980s. Reports in 1994 indicated that SA-4 is no longer in service in Russia. In spite of its age, SA-4 has never been used in combat and exports are believed to have been made to: Armenia, Azerbaijan, Belarus, Bulgaria, Czech Republic, Germany, Hungary, Kazakhstan, Poland, Slovakia and Ukraine.

In January 1971, an SA-4 brigade was airlifted to Cairo West airport, to provide coverage of a gap in Egyptian air space from Suez City south along the Gulf, but it was removed in 1972. The SA-4 'Ganef also went into Afghanistan with Soviet Forces in December 1979 and a brigade was stationed for a time around Kabul airport. In 1997, it was reported that, between 1993 and 1996, some 27 fire units of SA-4 and 349 missiles had been sold to Armenia.

Specifications

SA-4A
Length: 8.8 m
Body diameter: 0.86 m
Launch weight: 2,500 kg
Warhead: 135 kg HE fragmentation
Guidance: Command plus semi-active radar homing
Propulsion: Ramjet with 4 solid boosters
Range: 55 km

SA-4B
Length: 8.4 m
Body diameter: 0.86 m
Launch weight: 2,500 kg
Warhead: 135 kg HE fragmentation
Guidance: Command plus semi-active radar homing
Propulsion: Ramjet with 4 solid boosters
Range: 50 km

Associated radars
Surveillance radar: 'Long Track (IS-I2)
Frequency: 2-3 GHz (S-band)
Peak power: n/k
Range: 150 km

Height-finding radar: 'Thin Skin'
Frequency: 6-8 GHz (C-band)
Peak power: n/k
Range: 240 km

Engagement radar: 'Pat Hand' CW (IS-32)
Frequency: 6.44-6.88 GHz (C-band)
Peak power: n/k
Range: 85 km

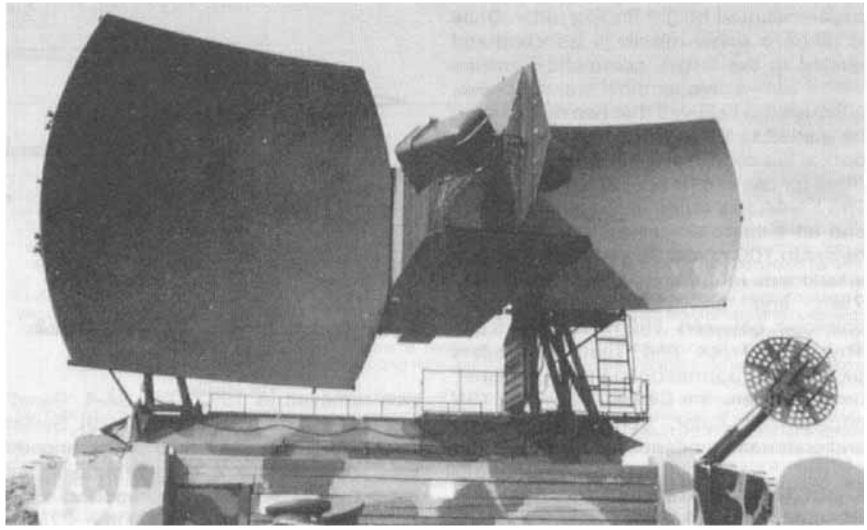
Contractors

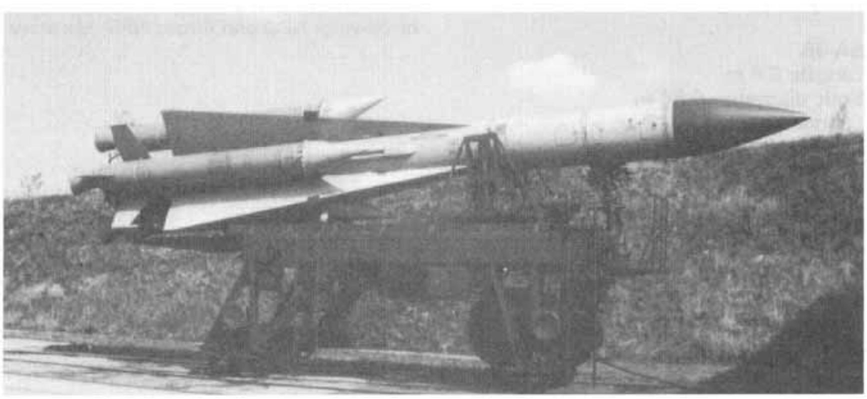
It is believed that Lyulev OKB designed the SA-4 system, but support is now provided by Novator NPO and Almaz NPO, Moscow.

SA-5 'Gammon' (S-200 Volga, 5V21/5V28)

Type
Medium-range, ground-based, solid propellant, theatre defence missile.

Development
The initial development of the Soviet S-200 Volga system, designated SA-5 'Gammon' by the US DoD, was carried out in the late 1950s. It is believed there were at least two systems in service, the S-200D and S-2OOV. There were export versions of these known as S-200DE and S-200VE, and that alternative Russian designators for this missile system were V-860. 5V21, 5V28, Angara and Vega. The NATO designators indicate that there were three versions of the SA-5; a conventional HE warhead SA-SA, a nuclear warhead SA-5B and another conventional warhead missile with improved manoeuvrability and terminal guidance, known as SA-5C. The SA-5 'Gammon' missile was the cause of considerable controversy in the US over many years, with some reports claiming that it hasa limited ABM capabilityand that it was tested in this role in the early 1970s. The primary role for the SA-5 was almost certainly high-flying aircraft, most probably the B-70 Valkyrie and SR-71 reconnaissance aircraft. In addition, the missile was probably intended for use against the standoff nuclear missiles such as Hound Dog, Skybolt and Blue Steel. Current use is probably aimed at jammer aircraft and E-3 AWACS, with an unconfirmed report that there is an optional passive radar terminal seeker fit for use against Airborne Early Warning (AEW) aircraft. In 1992, the Russians provided details of an upgraded SA-5D system, and this version may have been exported. A report in 1999 stated that Poland was upgrading some S-200 batteries, by fitting the launchers and engagement radars to wheeled and tracked vehicles.


A 'Square Pair' engagement radar, used with the SA-5 'Gammon' system. The small circular antenna on the right of the picture is most probably for the command link

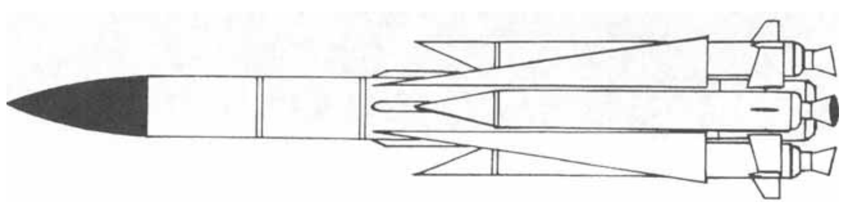

An SA-5 'Gammon' on a re-supply trolley


An SA-5 'Gammon' (S-200) missile on its fixed launcher assembly

Description
The SA-5 'Gammon' missile has four triangular wings, with four clipped-tip moving triangular control fins at the rear. The missile is 10.6 m long, with a body diameter of 0.86 m. It is believed that the missile weighs 2,800 kg at launch, including the four solid propellant booster motors which are wrapped around the rear half of the missile body between the wings and fins. The boosters are 4.9 m long and are jettisoned after launch at about 60 km range, when a sustainer motor takes over. Guidance in mid-course is by radio-command, with the missile and target being tracked by an C-band (6.62 to 6.99 GHz) 'Square Pair' CW radar with a range of 160 km. Terminal guidance is provided by a semi-active radar seeker in the missile. There is an unconfirmed report that a passive radar homing head can also be fitted to a fourth version, designated SA-5E. A large sustainer motor gives the missile a range of about 150 km. Earlier missiles are reported to have a liquid propellant sustainer motor and later versions solid propellant, but the range is most probably constrained by the performance of the 'Square Pair' engagement radar. There are two warhead options reported, a conventional 217 kg HE and a small nuclear warhead reported to be 25 kT, with probable options for proximity or command fuzing. SA-5 'Gammon' is a relatively heavy and unmanoeuvrable missile, with a poor low-level capability. Later modifications are thought to have improved both the manoeuvrability of the missile and the ECCM capabilities of the engagement radar. It is believed that SA-5 has a capability to intercept non-manoeuvring aircraft targets up to about 20 km (65,000 ft) altitude. The missile is mounted on a single-rail launcher and whilst it is transportable by air, it is not a mobile

system. It is believed that most systems now use the 'Bar Lock B' (Russian P-50) surveillance radar, which has six stacked beams operating at separate frequencies around 3 GHz, with a range of about 390 km. Height-finding is provided by the PRV-11 'Side Net' 2.56 to 2.7 GHz S-band radar.

The upgraded SA-5D version, offered for export in 1992, has a range increased to 300 km and intercept altitudes of between 300 m and 40 km. The missile is an improved 5V28 (S-200V system) version. It is believed that this missile uses new boost and sustainer motors, but that the launch weight remains at 2,800 kg. The launcher batteries can be up to 100 km from the command and control section. Each regiment has a 'Big Back L-band early warning radar, with a range of 500 km. The modified 5MV26 'Square Pair Mod 2' engagement radar has an increased range of 300 km, and is augmented by an aural IFF warning system.



A line diagram of the SA-5 'Gammon' missil 0010166

Operational status

The SA-5A 'Gammon' was first deployed in 1963, the SA-5B in 1970 and the SA-5C in the mid-1970s. Further improvements have been made since and an improved system, with a range of 300 km, may now be in service in several countries. It is believed that a large number of missiles, probably in excess of 2,000, were in service in 1980, but this number was reduced to 200 deployed in Russia at around 20 sites in 1998. The sites are reported to be within one regiment, with its headquarters at Molodechno near Kaliningrad. Some 10 batteries of ex-Russian missiles were sold to Iran between 1996 and 1998. SA-5 missile systems, possibly in a different export form, have been exported to Belarus, Bulgaria, Czech Republic, Georgia, Germany, India, Iran, Kazakhstan, North Korea, Libya, Poland, Slovakia, Syria and Ukraine. The Libyans used SA-5 'Gammon' missiles against US aircraft in March and April 1986, but these were countered with ECM and AGM-88 HARM attacks and no aircraft were hit. A test of a SA-5 missile from Ukraine in October 2001 accidentally hit and destroyed a Tu-I 54 airliner over the Black Sea, and this intercept occurred at a height of 11 km and a range of 270 km.

Specifications

Length: 10.6 m
Body diameter: 0.86 m
Launch weight: 2,800 kg
Warhead: 217 kg HE or nuclear 25 kT
Guidance: Command and semi-active or passive radar
Propulsion: Solid propellant
Range: 150 km (A/B/C), 300 km (D)

Associated radars
Surveillance radar: P-50 'Bar Lock B'
Frequency: 3 GHz (S-band)
Peak power: n/k
Range: 390 km

Height-finding radar: PRV-11 'Side Net'
Frequency: 2.56-2.7 GHz (S-band)
Peak power: n/k
Range: 180 km

Engagement radar: 'Square Pair'
Frequency: 6.62-6.99 GHz (C-band)
Peak power: n/k
Range: 160 km (Mod 1). 300 km (Mod 2)

Contractor

The SA-5 'Gammon' was designed by the Grushin OKB and is now supported by Almaz NPO, Moscow and Fakel MKB, Khimky.

SA-6 'Gainful' (9M9/9M336 Kub)

Type

Short-range, ground-based, ramjet-powered, theatre defence missile.

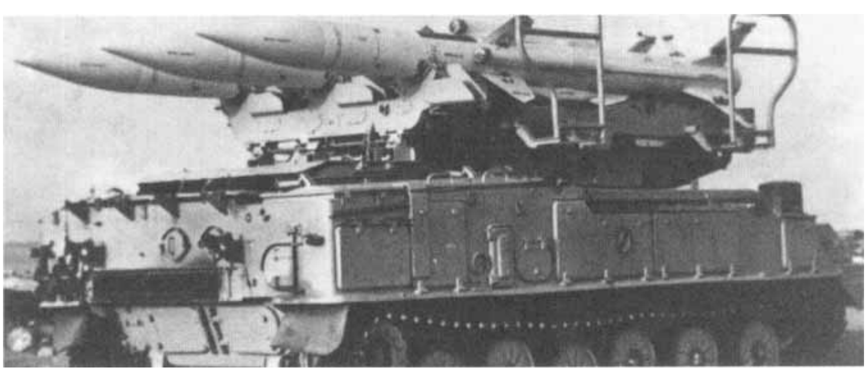
Development

Development of a divisional air defence missile system, known as the ZRK-SD Kub (Kvadrat), was begun by the Toropov's OKB-134 design bureau at Tushino in 1959. The system was intended to replace the S-60 57 mm radar-directed guns used by the former Soviet Ground Forces. For several reasons, development of the Kub fell behind schedule in the early 1960s. One reason being that the design bureau had also received a contract in 1959, to study the possibility of copying the US AIM-9B Sidewinder air-to-air missile, on the basis of two examples obtained from China. As a result of this and certain development problems, prototype testing of the missile (Kub 9M9) did not take place until 1965. Initial deployment of trials units followed in 1967, but continuing problems prolonged the acceptance phase. In spite of the problems, the Kub system was first publicly seen in Moscow in November 1967 and it received the NATO designation SA-6 'Gainful'. The export version of SA-6 'Gainful' is sometimes referred to as Kvadrat (Quadrant). However, it is unclear whether this is the name given to the export model of the system, or whether Kvadrat is the name of the 9M9 missile rather than the whole system. The SA-6 'Gainful' first saw action during the 1973 Middle East war with Syria and Egypt. The Israeli Air Force appreciated the vulnerability of the engagement radar and the possibilities of saturating the system.

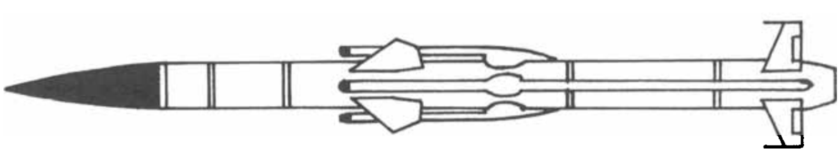
The Russian Ground Forces PVO already had a new system, the SA-8 'Gecko' ZRK Romb, entering service, which remedied this problem by providing each TEL (Transporter-Erector-Launcher) with an engagement radar, resulting in TELAR (Transporter-Erector-Launcher And Radar). The SA-8 'Gecko' was to become the new Russian divisional air defence missile system. As a result, an SA-6 follow-on with comparable range and a TELAR launcher was eventually fielded in 1982 as the SA-11 'Gadfly'. The SA-11 programme had prolonged difficulties with the missile, leading to the decision, around 1976, to develop a stopgap system combining SA-6 'Gainful' and SA-11 'Gadfly' features. The result, designated SA-6B 'Gainful' Mod 1 by NATO, mated a derivative of the proven SA-6 missile (9M336) with the SA-11 'Gadfly' TELAR. These Mod 1 systems began to appear in 1979 and were first seen in the Military District opposite Afghanistan. From that time on, the deployment pattern appears to have been to issue a single SA-6B 'Gainful' Mod 1 TELAR per Kub battery, rather than to deploy regiments entirely equipped with the new vehicle. This process apparently continued into the mid-1980s. by which time the SA-11 'Gadfly' was coming into service. During its service life, there have been nine variants of the SA-6 missile, designated 3M9, 9M9, 9M9M/M1/M2/M3/M3A/MA and 9M336 by the Russians. There are no corresponding NATO designations. In 1996, Vympel released details of a modified SA-6 missile (9M9M3 version) for use as a target missile, with the new designator 3M20M3, which simply exchanged the warhead assembly for a target module containing an autopilot, chaff and flare dispenser, miss-distance recorder and a missile self-destruct mechanism.

India has developed a version of SA-6, known as Akash and this is described in a separate entry. Reports suggest that Serbia has modified SA-6 missiles to improve their performance, as well as extending their service lives. In 1999, Poland completed a prototype upgrade to a SA-6 TELAR vehicle, incorporating digital electronics to improve the reliability and maintainability of the system, as well as adding a NATO IFF, low-light level TV and IR sensors. In 1999, Agat exhibited an active radar seeker option for SA-6 missiles (Kub M4), using a newly developed 911-1103M seeker with a range of 40 km against fighter aircraft targets. It is believed that Iraq upgraded some SA-6 systems to intercept at higher altitude, with a reported 22 km, but this has not been confirmed. In 2001 Slovakia displayed a new command and control vehicle for use with SA-6, using a Tatrapan T1 6 × 6 wheeled chassis. This vehicle combines the roles of two earlier

A 'Straight Flush' SA-6 radar system on its tracked vehicle, showing the circular engagement radar above the parabolic surveillance radar antenna



A Libyan SA-6 'Gainful' triple transporter-erector-launcher vehicle (Soviet Military Power 1988)



***A** line diagram of the **SA-6** 'Gainful' missile*

vehicles used for command and control, and communications. The new vehicle has five operator stations with VHF and UHF datalinks, weighs 19,500 kg, and has a length of 8.46 m.

Description

The SA-6 is quite different from other Russian SAMs, in that it has four long slender tube air inlet ducts mounted mid-body between the wings. At mid-body, there are four clipped movable triangular wings for pitch and yaw control. Just forward of the jettisonable boat-tail are four in-line clipped delta fins with ailerons for roll control. The missile is 5.8 m long, has a body diameter of 0.34 m and with a 59 kg HE fragmentation warhead, weighs 600 kg at launch.

The missile is fitted with a C-band transmitter beacon mounted on the tail to assist the engagement radar in tracking the missile. The guidance system of the missile relies on continuous wave radar illumination of the target by the 1S-914 to 8 GHz (C-band) 'Straight Flush' surveillance/engagement radar. In mid-course, the radar communicates via an X-band command uplink to a reference antenna receiver on the missile tail. In the terminal phase, the 'Straight Flush' radar provides the CW target illumination for the semi-active radar seeker. Up to three missiles can be guided towards the same target by the engagement radar, which has a TV tracker for use in heavy ECM conditions. A laser range-finder has been added to later SA-6 systems. The early versions of the missile did not have the prominent fin antenna, but were fitted with interferometer antennas on the central fins. These may have been associated with proximity fuzing rather than missile guidance, since a gimballed seeker is fitted in the missile nose. The propulsion system uses a solid fuel integral rocket/ramjet. On launch, the solid propellant boost motor in the rear of the missile fuselage is ignited. The booster has a duration of 4.1 seconds, boosting the missile to a speed of M1.5. At this point, the nozzle of the boost motor falls away, caps over the four air inlet ports are removed and the ramjet system is activated. The chamber, which had contained the solid propellant booster motor, acts like an afterburner chamber. The ramjet propulsion boosts the missile speed to M2.8 and burns for 22.5 seconds. The warhead is detonated by contact or radar proximity fuzes and has a lethal radius of 5 m against a typical fighter-sized target aircraft at low level. The complete mobile SA-6 system is known as Kub in Russia; this consists of a 2P25 TEL carrying three missiles, a 2T7M transloader with three reload missiles and a IS-91 'Straight Flush' radar vehicle.

The 2P25 TEL has a crew of three, and is a tracked vehicle with a weight of 1,400 kg, length of 7.4 m, width of 3.2 m and a maximum road speed of 45 km/h. Each regiment has an HQ vehicle, early warning and height-finder radars and five SA-6 batteries. Each battery has a 'Straight Flush' radar, four SA-6 TEL and four transloaders. Several early warning and surveillance radars have been used with SA-6 'Gainful' batteries, but it is believed that the present systems use P-18 (1RL-131) 3-D surveillance radars, or the P-40 complex with a 2-D (1RL-128) surveillance radar and a PRV-16 (1RL-132) height-finder radar. In addition, the lower parabolic antenna on 'Straight Flush' is for surveillance and has a range of 55 km against fighter aircraft targets. The SA-6 has range limits of 3 to 25 km and an altitude engagement envelope of between 30 to 15,000 m. SA-6 missiles have been fired using only passive electro-optic sensors for surveillance and acquisition, providing command guidance until about 5 seconds before impact, when the engagement radar is switched on to allow the semi-active radar seeker in the missile to locate the target.

Operational status

SA-6 'Gainful' entered operational service in 1970. This was followed in 1979 by an updated version, the SA-6B 'Gainful' Mod 1. The system is believed to have remained in production throughout the 1980s. at around 800 missiles per year. In 1992, there were reported to be 850 SA-6 triple missile TELs in service in Russia. The first known action was by Syria and Egypt, during the first few days of the 1973 Middle East war, when it proved highly effective against Israeli aircraft. It has seen subsequent combat service in the war between Iran and Iraq and in Lebanon during 1982. Additionally, it has been used by both the Polasario Front and Algeria in border skirmishes with Morocco, destroying at least five aircraft. It was used by Libya against US aircraft in 1986 and against French aircraft in the battles in northern Chad in 1986 and 1987. An American F-16 was hit by a SA-6 missile over Bosnia in 1996, and Iraq has used SA-6 missiles against US and UK aircraft between 1998 and 2002.

The SA-6 'Gainful' system has been exported to the following countries: Algeria, Angola, Azerbaijan, Belarus, Bulgaria, Cuba, Czech Republic, Egypt, Georgia, Germany, Guinea, Guinea-Bissau, Hungary, India. Iran. Iraq. Kazakhstan, Libya, Mozambique, Poland, Romania, Slovakia, Somalia, Syria, Tanzania, Ukraine, Vietnam, Yemen and Yugoslavia. In 1996, it was reported that the Indian SAM known as Akash was based on the SA-6 'Gainful' design, but using the SA-10 'Grumble' 'Flap Lid-B' (36N6E) phased array engagement radar. Around 100 Indian SA-6 fire units were being upgraded by Poland's Centrex Trading during 2001/2002.

Specifications

Length: 5.8 m
Body diameter: 0.34 m
Launch weight: 600 kg
Warhead: 59 kg HE fragmentation
Guidance: Command and semi-active radar
Propulsion: Ramjet
Range: 25 km

Associated radars
Surveillance/Engagement radar: 'Straight Flush' (IS-91)
Frequency: 4-6 and 6-8 GHz (C-band)
Peak power: n/k
Range: 55 km surveillance and 30 km engagement

Contractors

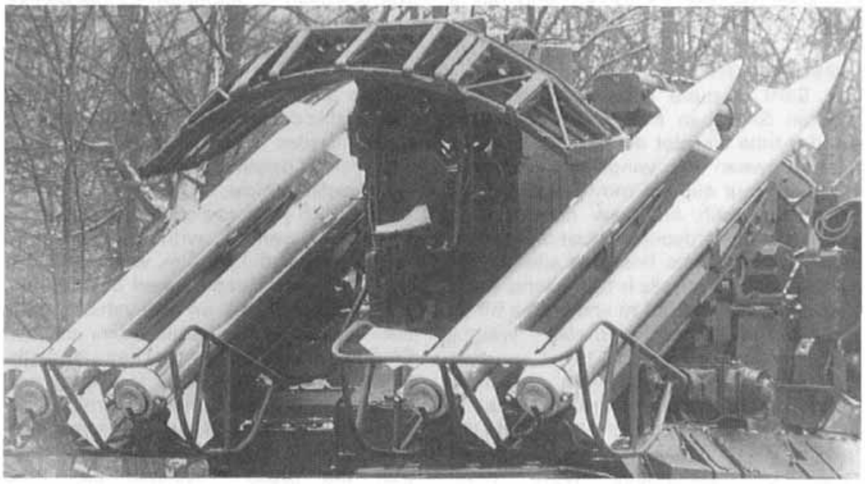
SA-6 'Gainful' was designed by the Toropov OKB-134, Tushino. Support is provided by Vympel MKB, Moscow, NIIP at Zhukovsky, and by the Ulyanovsk Mechanical Plant.

SA-8 'Gecko' (9M33 Osa)

Type
Short-range, ground-based, solid propellant, theatre defence missile.

Development
In 1963, the Russian Navy sought an effective low-altitude air defence system for small surface warships, as the existing low- to medium-altitude system, the SA-N-1 'Goa', was too large. Adoption of an army missile may have been a consideration, as in the case of the SA-N-1 'Goa' which was an adaptation of the SA-3 'Goa' system. However, SA-6 'Gainful' was delayed and was too large for navy use. The Russian Navy therefore decided to pursue the programme itself. The missile system is 9K33 Romb, but the missile itself was designated Osa-M (Wasp; M is the abbreviation for morskiv, meaning naval) and given the number 9M33. The system was first tested in 1965, entered service with the Russian Navy in 1968 and was given the NATO designation SA-N-4 'Gecko'. The Russian Army version, the ZRK Romb was first seen in 1973 and the initial production type, designated SA-8A 'Gecko' Mod 0, was first publicly displayed in November 1975. The SA-8 was the first mobile air defence missile system incorporating its own engagement radars on a single vehicle, known as the Osa TELAR 9A33 (Transporter-Erector-Launcher And Radar) vehicle. The SA-8 fulfils the same role as the SA-6 'Gainful', but does not replace it, as they were procured almost simultaneously. The radar system on the SA-8 TELAR received the NATO codename 'Land Roll'. It was derived from the naval 'Pop Group' radar system but is smaller, since it does not require the elaborate stabilisation system. An improved system, designated the SA-8B 'Gecko' Mod 1, (9M33M Osa-AK) was first seen in Germany in 1980. It had improvements added to the launcher configuration, carrying six missiles in ribbed containers.

A further improvement entered service in 1985, known in Russia as Osa-AKM. This missile had its guidance and velocity improved, to give an increased maximum range. There have been unconfirmed reports of other possible versions of the missile with both infra-red and semi-active radar terminal homing seekers. The Russians have developed the 'Tor' system, designated SA-15 'Gauntlet' by NATO. It entered service in 1984 and is progressively replacing SA-8. In 1999, Poland upgraded a prototype SA-8 TELAR with digital electronics, a NATO IFF and an IRST sensor for use in place of the engagement radar in ECM conditions. A similar modification has been made in Greece, but using different components. A report in 2000 stated that Antey NPO was offering further upgrades to SA-8 missiles and systems, including an automatic fire-control system, and increased missile lethality and range.



Close-up of four early *SA-8A* Mod 0 missiles. ***Note*** the folded-down search radar

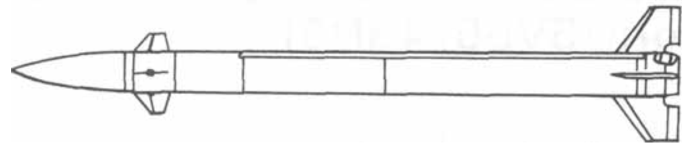
The improved six-launcher *SA-8B 'Gecko'* Mod *1* on parade in Red Square with the *'Land Roll' radar* (US Army)

Description
The SA-8 'Gecko' has a slender cylindrical body with four small clipped delta control fins situated well forward on the nose and four fixed in-line clipped delta tailfins. The missile is 3.15 m long, has a body diameter of 0.21 m and with a 19 kg HE fragmentation warhead, weighs 126 kg at launch. The missile is fitted with two beacon transponders mounted on the rear body. Other than the possibility of folding rear fins on the Mod 1, there appears to be no physical difference between the Mod 0 and the Mod 1 missiles. However, the information available mentions internal improvements to the guidance system and increased speed. The radar system associated with the SA-8 'Gecko' is designated 'Land Roll' by NATO. The system is reported to be of the frequency-agile monopulse type. It consists of an elliptical rotating surveillance antenna mounted on top of the radar assembly, operates in C-band (6 to 8 GHz) and has a 30 km acquisition range against aircraft targets. The large pulsed X-band (14.5 GHz) engagement antenna is mounted below it in the centre of the assembly having a maximum tracking range of about 20 km.

Mounted on either side of the tracking radar antenna is a small, X-band parabolic dish antenna to track the missile. Below this is a small circular antenna, which emits an I-band uplink capture beam to gather the missile shortly after launch. The final antennas in the array are two small white rectangular ones, one on either side of the radar assembly mounted alongside the X-band antenna. These are used for command uplink to the missile. This twin-antenna system permits the 'Land Roll' radar to control up to two missiles simultaneously against a single target. Furthermore, the two missiles can be guided on different frequencies to further complicate ECM. There is also a tubular device fitted to and above the tracking radar. This device is an Electro-Optic/Low-Light Television (EO/LLTV) optical tracker, which would be used to track the target when the main tracking radar is jammed by ECM.

The SA-8 TELAR vehicle is a new six-wheeled design. designated BAZ-5937. It is based on a number of earlier six wheeled all-terrain vehicles and is fully amphibious. The initial production SA-8A 'Gecko' Mod 0 carried four missiles on exposed launchers. The improved Mod 1 TELAR (9P35M2) had modifications to the launcher system, which allowed it to carry six missiles in rectangular tube containers. The Mod 1 TELAR vehicle has a crew of five, with a 300 HP diesel engine and a 91120 gas-turbine power generator for use when the vehicle is stationary. The vehicle has a maximum road speed of 80 km/h and in water, is capable of 8 km/h. The road range is about 500 km. The SA-8 system can be made operational 5 minutes after arriving at a new site. Some batteries have a Sborka 9S80 mobile command and control vehicle, which is fitted with a surveillance radar. This radar has a range of 40 km.

When launched, the missile's booster motor burns for 2 seconds, this permits the radar to gather and control it at very short ranges (1.5 km). The sustainer motor has a 15 second burn, bringing the missile to a top speed of about M2.0. Once launched, the missile is command-guided for the whole flight and the warhead is detonated by its proximity fuze or possible command. The warhead is said to have a lethal radius of 5 m at low altitude against a fighter aircraft target. The SA-8A Mod 0 missile has range limits of 1.5 to 10 km and an altitude engagement envelope of between 10 and 5,000 m. The SA-8B Mod 1 has a greater maximum range of 15 km, but the same altitude envelope. The intercept range is reduced to 6 km when the TV sight is used alone. An SA-8 battery comprises four TELAR vehicles and two Osa 9T217 transloader vehicles with reload missiles. A reload time of 5 minutes has been reported per TELAR.



*A **line** diagram of the SA-8 'Gecko' missile*

Operational status

Although the naval version SA-N-4A 'Gecko' entered service in 1968, the ground-based mobile version SA-8A 'Gecko' Mod 0 was not seen to have entered service with the former Soviet armed forces until 1974. The improved SA-8B 'Gecko' Mod 1 was first seen in a military parade in 1980. In 1987, it was reported that the Russians had 800 launch vehicles in service and it was estimated that annual production of the SA-8 'Gecko' missile had been running at 2,000 missiles. By 1994, it is believed that the Russian launch vehicles had reduced to 400, following the introduction of the SA-15 'Gauntlet' replacement system. Exports have been made to the following countries: Algeria, Angola, Armenia, Belarus, Croatia, Czech Republic, Germany, Greece, Guinea-Bissau, Hungary, India, Iraq, Jordan, Kazakhstan, Kuwait, Libya, Mozambique, Nicaragua, Poland, Romania, Slovakia, Syria and Yugoslavia. SA-8 'Gecko' missiles were used by the Syrians in the Bekaa Valley in 1982. It is believed that the system has also been used in Angola, and captured SA-8s were in service in South Africa. SA-8s were also used by Libya in 1986 and by Iraq in 1991. In 1997, it was reported that up to 40 fire units had been exported to Armenia between 1993 and 1996. In 1992 Greece bought 12 SA-8 TELAR and missiles from the former East Germany, and ordered a further 16 launchers in 1999. In 2001 Greece had one battalion with eight batteries in service. The Indian Army has replaced warheads and motors on some SA-8 missiles, and in 1999 placed a contract with Centrex Trading in Poland for the upgrade of 50 fire units. In April 2001 the Russians demonstrated an upgraded SA-8B Mod 1 version in India at the Chandipur test range.

Specifications

Length: 3.15 m
Body diameter: 0.21 m
Launch weight: 126 kg
Warhead: 19 kg HE fragmentation
Guidance: Command
Propulsion: Solid propellant
Range: 10 km (Mod 0); 15 km (Mod 1)

Associated radars
Surveillance/Engagement radar: 'Land Roll'
Frequency: 6-8 GHz (C-band) and 14.5 GHz (X-band)
Peak power: n/k
Range: 30 km surveillance, 20 km engagement

Contractor

The SA-8 'Gecko' was designed by the Grushin OKB, but is now supported by Antey NPO, Moscow and Fakel MKB, Khimky.

SA-10/20 'Grumble' (S-300, S-300 PMU, Buk/ Favorit/5V55/48N6)

Type

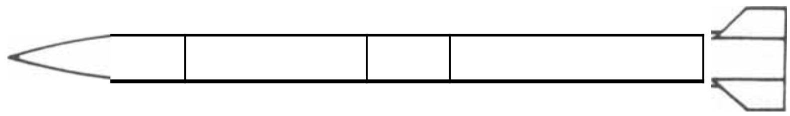
Short- and medium-range, ground-based, solid propellant, theatre defence missiles.

Development

Designed in the late 1960s and jointly developed in the 1970s. the SA-10 and SA-N-6 'Grumble' programmes were managed by the Grushin and Raspletin missile design bureaus (now the Almaz NPO and Fakel MKB). The missile systems have the Russian designator S-300 or S-300 PMU and are named Buk (SA-IO), Favorit (SA-20) or Fort/Rif (SA-N-6). It is thought that the initial requirement was to develop a high-altitude, surface-to-air missile, also capable of defending against the larger air-to-surface missiles. This requirement was almost certainly modified in the early 1970s. during a protracted development and evaluation phase, to include an improved capability against low-flying aircraft and missiles. There has always been the belief that SA-IO 'Grumble' has a capability against ASM and SSM and reports indicate that trials in the Far East against simulated ship-launched cruise missiles were successfully completed in 1991.

SA-10 has probably only a limited capability against ballistic missiles, but successful intercepts were reported in 1996 against SS-1 'Scud B' and other short-range ballistic missile targets. The latest version, S-300 PMU2 Favorit (SA-20). has a reported capability to intercept 1,000 km range ballistic missiles. There are several versions of 'Grumble', SA-1OA (S-300 P) entered service in 1980 and used the 5V55K missile with a range of 45 km. SA-10B (S-300 PM) entered service in 1982 and used the 5V55R missile with a range of 75 km. The SA-1OC (S-300 PMU) entered service in 1985 and uses the 5V559 missile with a range of 90 km. The SA-10D (S-300 PMU1) entered service in 1992, incorporated several modifications to the radars and command and control centre and introduced a new missile designated 48N6 with a range of 150 km.

The latest version, SA-20 (S-300 PMU2 Favorit), includes a 48N6/2 missile with a range of 200 km and a new surveillance



A line diagram of the SA-10 missile 0010167

This mobile SA-10 'Grumble' TEL has a 5P85T trailer with four missile canisters and is towed by a Ural 375 tractor unit (Christopher F Foss)

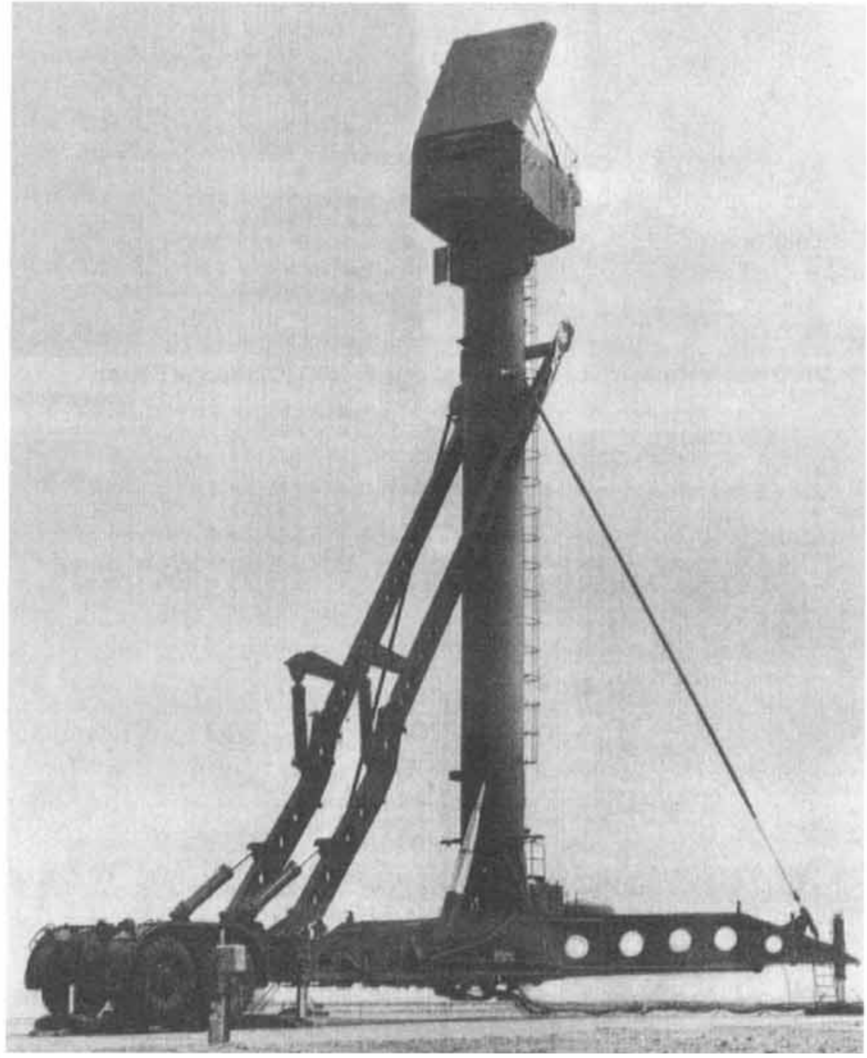
Two SA-10 'Grumble' transporter-erector-launcher vehicles with the four missile canisters in the vertical position ready for launching. The additional cabin on the right hand vehicle is believed to be for the launch crew

radar. The SA-20 system has been offered for export from 1998, but it is not known if or when it entered service in Russia. There are unconfirmed reports that an active radar terminal seeker has been developed for the SA-10/20 system missiles, but this has not been offered for export. The Russians change the designators for their export systems, adding an E, giving for example 48N6E2 for the latest missile version, or 36D6E for a radar. A realistic assessment of the performance capability of the SA-10/20 system would ascribe a capability similar to that of the US MIM-104 Patriot system, but with considerably increased range.

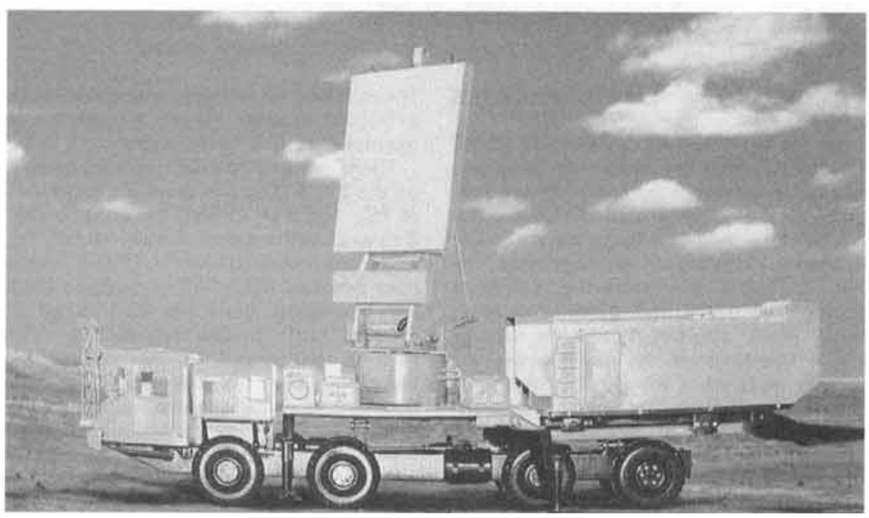
The later SA-1OD and SA-20 'Grumble' versions have the capability to intercept short-range ballistic missiles and cruise missiles flying at low level. The system would also be most effective against aircraft targets.

In 1995, there were unconfirmed reports of China building SA-10 missile systems under licence as the HQ-10 and modifying the SA-IO with MIM-104 Patriot technologies, designating it as the HQ-9. The Chinese exhibited a FT-2000 missile in 1998, clearly using some SA-IO technologies and components. In 1998 two new Russian missiles were exhibited, designated 9M96 and 9M96/2, making up a new Trieumf surface-to-air missile system. These two missiles are designed so that four missile canisters can be fitted in place of a standard SA-10/20 canister and used with the S-300 PMU2 (SA-20) system.

These missiles are similar in concept to that of the US PAC-3, which was designed to be launched from modified MIM-104 Patriot launchers. The 9M96 missile has a launch weight of 330 kg and a maximum range of 50 km. The larger version, designated 9M96/2, has a launch weight of 420 kg and a range of 120 km. The 9M96 and 9M96/2 missiles are also being offered for export as a separate system, called S-400 Trieumf, mounted on wheeled TEL vehicles each carrying 12 missiles. For more details on the Trieumf system see the separate entry.



A tower-mounted 'Flap-Lid A' engagement radar



An artist's impression of the 96L6 3-D surveillance radar associated with the SA-20 missile system, exhibitedm 7997 (Duncan Lennox)

0010170

Description

The earlier 5V55K (SA-10A) missiles are 7.11 m long, have a body diameter of 0.45 m and a launch weight of 1,590 kg. The HE fragmentation warhead weight is 133 kg and the missile has an RF fuze. The minimum intercept range is 5 km and the maximum range is 45 km. The 5V55R (SA-10B) missile is similar to that for the SA-1OA system, but has an increased maximum range to 75 km. The 5V559 (SA-IOC) missile version is 7.25 m long and has a launch weight increased to 1,625 kg. This missile has a range of 90 km. The SA-1OC system has the capability to intercept ballistic missiles with a range up to 300 km, with the intercept occurring at ranges up to 30 km from the launcher. The 48N6 (SA-10D) missile is longer at 7.5 m, has a body diameter of 0.52 m and has a launch weight of 1,800 kg. The HE fragmentation warhead weight is increased to 143 kg and it is believed that the warhead fragments are focussed towards the target direction. The missile uses an RF fuze. The 48N6 missile has a peak velocity of 1.9 km/s, which is reached 12 seconds after motor ignition. The minimum intercept range is 3 km and the maximum range is 150 km. The SA-1OD system has a capability to intercept ballistic missiles with ranges of 600 km, with the intercepts taking place at ranges up to 40 km from the launcher. The latest version, the 48N6/2 (SA-20) missile, is 7.5 m long, has a body diameter of 0.52 m and has a launch weight of 1,840 kg. This version has a warhead weight of 180 kg and this is also believed to use a focussed HE fragmentation system and an RF fuze. The 48N6/2 missile has a peak velocity of 2.0 km/s, and is reported to be able to intercept ballistic missiles with ranges up to 1,000 km. The minimum

An SA-10 missile displayed in a sectioned canister in 1993 (Christopher F Foss)
2000/0081834

A 'Flap-Lid B' engagement radar, part of the mobile SA-10 'Grumble' system

range is 3 km, and the maximum range is 200 km.

As far as is known, all the SA-10/20 family of missiles have four clipped folding triangular moving control fins at the rear and four thrust vector control vanes in the motor efflux. All the missiles have a single solid-propellant motor, although this may have a boost and sustain phase burn profile. The 48N6 and 48N6/2 missiles have small side-thrust motors located about one-third of the way down the missile body from the nose, to improve the manoeuvrability in the terminal engagement phase. Guidance in mid-course is inertial with updates from the engagement radar and in the terminal phase, a monopulse semi-active radar track-via-missile mode is used, similar to that used in the US MIM-104 Patriot SAM system. SA-10/20 is vertically launched by a hot gas cartridge in the canister base and the motor ignited after launch when the missile has reached an altitude of 25 m. All SA-10/20 versions have a capability of intercept against targets between 10 m and 27 km (88,000 ft) altitude. It is reported that some SA-10 'Grumble' missiles have alternative nuclear warheads, believed to have a yield of 25 kT.

The missile is transported in and fired from a 500 kg canister, which is sealed and maintenance free for 10 years.

There are four missile canisters carried on the 8 × 8 TELs and there are two types of TEL. A trailer, 5P85T, towed by a Ural 375 truck with a total weight of 35,600 kg, and a self-propelled version, 5P85S, which uses modified MAZ 543 or modified MAZ 7911 vehicles from the SS-1 'Scud B' system and weighs 42,150 kg. The missiles are raised to the vertical for launching and the vehicles have four hydraulic jacks lowered for stability during launch. The missiles can be salvoed at an interval of between 3 and 5 seconds. A typical combat crew for the launchers is four men. Reload missiles are carried on a 5T58 reload vehicle. They are loaded onto the launcher TELs by a 22T6 loading vehicle with a hydraulic crane. A site survey vehicle used with the SA-10 system has the designator 1T12.

A three-dimensional phased array pulse Doppler surveillance radar, with the Russian designator 36D6 and with the NATO codename 'Tin Shield', was used initially with the SA-10. Subsequently, other surveillance radars have been used, including the 64N6 'Tombstone' and the new 96L6 multifunction radar developed for the S-300 PMU2 (SA-20) system. The NIIIP 64N6 surveillance radar is a 3-D type with a dual-faced phased array antenna, using electronic beam stearing in elevation and azimuth as well as mechanical rotation at 6 or 12 rpm. The 64N6 radar is believed to operate in C-band. This radar can take bearings on active jammers, uses MTI, clutter blanking and frequency agility, and has a range of 250 km against a fighter aircraft. The radar is carried on a wheeled vehicle weighing 60,000 kg, and has four operators and a self-contained gas turbine electric power generator.

The LEMZ 96L6 L-band surveillance radar is also a 3-D type, but has a single-face phased array antenna with electronic scan with three beams in elevation and a variable rate mechanical rotation in azimuth. A sector scan covering 120° in azimuth is covered at 5 rpm, and a 360" rotation at 10 rpm. This radar is co-ordinated with the command post, and mounted on a MAZ 7930 wheeled chassis. The antenna can be tower mounted (966AA14) or carried on a separate trailer, both located up to 100 m from the control station. The radar has a range of 300 km, and can track up to 100 targets with an elevation of –3 to +60° against targets with speeds from 30 to 2,800 m/s. A typical SA-10 battery consists of a command and control vehicle 54K6, an engagement radar vehicle, up to four launch vehicles each with four missiles, plus associated missile transporter (5T58), reload (22T6) vehicles and a maintenance section (TZM). The Russians claim that a mobile battery can be operational within 5 minutes of arrival at a new site that has been pre-surveyed, but 100 minutes if the deployment includes the tower-mounted radar. The initial engagement radar has the NATO codename of 'Flap-Lid' and the Russian designator 30N6. This is a phased-array S-band system, operating at a frequency of 2 to 3 GHz. It provides for the simultaneous tracking of six targets and the capability of engaging each of these with either one or two missiles. It is claimed that the radar is highly resistant to ECM. has IFF, a missile command link and a high-resolution capability. There are at least two versions of the 'Flap-Lid'. The 'A version is a trailer-mounted, semi-mobile version. It is mounted on a 15 m high tower to increase its effective range against low-altitude targets and is also used in densely wooded areas. The 'Flap Lid B' is truck-mounted (Russian RPN), on a modified MAZ-7310 vehicle and when travelling, the SA-10 radar antenna is lowered to the horizontal, but when deployed, it is raised to an angle of about 60" in a similar manner to the US MIM-104 Patriot radar. The 'Flap-Lid' radar has a target elevation coverage reported to be from 0 to 50°, but it is believed that later versions have been modified to provide cover up to 75° for ballistic missile defence. An alternative engagement radar has been reported, with the Russian designator 5N66, which is tower mounted similar to the 'Flap-Lid A. A new low-altitude target detection radar has been developed for the S-300 PMU1/2 systems, using a LEMZ 76N6 radar mounted on either a 40V6M tower (24 m high) or a 40V6MD tower (39 m high). This new

A 76N6 'Clam Shell' low-level engagement radar antenna assembly on a raised tower 0044957

An SA-10 Grumble system command and control vehicle, 54K6, displayed in 1993 (Paul Beaver)

radar has the NATO designator 'Clam Shell' and has been developed to improve the low-level performance against small RCS missile targets. The FA-51MU antenna on this radar has vertical beamwidths of 1 or 6°, with a detection range against aircraft targets at 1 km altitude of 120 km. The 76N6 'Clam Shell' radar is mounted on a 5T58 semi-trailer and is towed by a MAZ 537 tractor unit. The four operators have a F52MU modular shelter, which is also on the semi-trailer.

The command and control system used with the SA-10/20 'Grumble' systems is designated 83M6 and is used to net the engagement radars for up to six systems together with surveillance and additional low-altitude radars. The command post (54K8) is vehicle mounted and has six operator positions. The command post has data covering a radius of 300 km and can track 100 targets whilst controlling up to six intercepts. Two missiles can be launched against each target if required.

The 83M6/2 system, which is used with the latest S-300 PMU2 Favorit (SA-20) version, has been upgraded to give an improved performance against cruise missile and ballistic missile targets.

Reports indicate that the SA-10/20 'Grumble' command and control systems, known in Russia as the 83M6 Baykal 1 and 83M6/1 Senezh-M1, can be netted to integrate several air defence systems together and share target allocations. It is believed that SA-10/20 systems can now be netted with SA-5 'Gammon' and SA-12 'Gladiator/Giant' systems, and interoperate with fighter air defence zones controlling around 70 to 80 SAM launchers covering a front line of around 600 km.

Operational status

SA-10A 'Grumble' (S-300P) entered service in 1980 and the SA-10B (S-300PM) systems in 1982. SA-10C (S-300PMU) entered service in 1985, SA-10D (S-300PMU1), with the 48N6 missile entering service in 1992. The latest system, SA-20 (*S-300* PMU2), started development in 1990 and may have entered service in 2000. The first flight test of a SA-20 missile, the 48N6/2, was reported in August 1995 and there have been several further tests against short-range ballistic missiles such as the SS-1 'Scud B'. A total of around 40 flight tests had been made by 2001, following limited production that started in 1997. It is reported that there are some 150 fixed SA-10/20 sites in Russia, with the major deployment centred around Moscow and over half of the sites in that region. Estimates from the US suggest that production of the SA-10 missiles was around 1,600 missiles a year in the late 1980s and that a total of approximately 10,000 missiles were in service by 1990, with perhaps as many as 1,600 mobile SA-10/20 launchers in service. Reports in 1995 suggested that 1,750 mobile SA-10B/C/D launchers were then in service in the Russian Federation.

Flight tests were reported from Kapustin Yar in early 1999, using SA-20 launchers modified with three SA-10/20 missiles and four 9M96 missiles to test the integration of the Trieumf system missiles and canisters with the SA-10/20 TEL and radars.

The SA-10 system has been exported to Belarus, Bulgaria, China, Croatia, Czech Republic, Greece (via Cyprus), Kazakhstan, Poland, Slovakia and Ukraine. An additional order from Slovakia was cancelled in 1999. Reports of the export of SA-10 missiles to Hungary, India, Iran, Libya, Serbia and Syria have not been confirmed, although the Russians have been promoting exports since early 1991. A small number of SA-10 missiles were exported to the USA in 1994 for evaluation (reportedly from Belarus), as was a 'Flap-Lid' radar (reportedly from Ukraine).

In 1997, Russia announced the order of SA-10 missiles by Cyprus, with delivery planned to start in 1998, but in December 1998 the order was transferred to Greece, with two battalions of the missiles deployed on the island of Crete in 1999. Israel is reported to have acquired some SA-10 components in 1998. Iran is reported to have ordered SA-10D missiles in March 2001. India is reported to have leased two systems for a years trial in 2002, and to have ordered six SA-10D systems with 330 missiles in June 2001. Unconfirmed reports suggest that some components, believed just to be missiles, were sold to Serbia early in 1999, but it is believed that these were not used against NATO aircraft and remain in storage. In 2000, Croatia is reported to have returned its SA-10 components to Ukraine.

China ordered 120 SA-10D missile systems, and is reported to be building SA-10 missiles under licence, with the Chinese designator HQ-10. In 2000, it was reported that three SA-10 missile bases had been built near Longtien on the Taiwan Straits. There are unconfirmed reports that an improved version, designated HQ-9, is being developed, using technologies possibly similar to MIM-104 Patriot systems. In 1998, the Chinese displayed an FT-2000 SAM using some SA-10 technologies and components, particularly the TEL vehicle 5P85S which appears to have been used with little change. In 2000 a report indicated that the missile used in the FT-2000 system was similar to the SA-10C missile 5V559.

Specifications

SA-10A/B/C (5V55K)/(5V55R)/(5V559)
Length: 7.11 m (A/B) and 7.25 m (C)
Body diameter: 0.45 m
Launch weight: 1,590 kg (A/B) and 1,625 kg (C)
Warhead: 133 kg HE or nuclear
Guidance: Inertial with updates and semi-active radar TVM
Propulsion: Solid propellant
Range: 45 km (A), 75 km (B) or 90 km (C)

SA-10D/SA-20 (48N6)/(48N6/2)
Length: 7.50 m
Body diameter: 0.52 m
Launch weight: 1,800 kg (10D) and 1,840 kg (20)
Warhead: 143 kg HE (10D) and 180 kg HE (20)
Guidance: Inertial with updates and semi-active radar TVM
Propulsion: Solid propellant
Range: 150 km (10D) and 200 km (20)

Associated radars
Surveillance radar: 36D6 'Tin Shield'
Frequency: n/k
Peak power: n/k
Range: 200 km

Surveillance radar: 64N6 'Tombstone'
Frequency: 4-6 GHz (C-band)
Peak power: n/k
Range: 250 km

Surveillance radar: 96L6
Frequency: 1-2 GHz (L-band)
Peak power: n/k
Range: 300 km

Engagement radar: 'Flap-Lid A/B' (30N6)
Frequency: 2-3 GHz (S-band)
Peak power: n/k
Range: 100 km

Engagement radar; 'Clam Shell' (76N6)
Frequency: n/k
Peak power: n/k
Range; 120 km

Contractors

SA-IO 'Grumble' was designed by the Grushin and Raspletin OKB, with the Bunkin OKB providing the radar systems design and Proton NPO the command and control system design. The land-based versions, SA-10A/B/C/D and SA-20 (S-300/S-300 PMU, Buk/Favorit), are being supported by Almaz NPO, Moscow, Fakel MKB, Khimky, Defence Systems, Moscow, Lianozovo Electromechanical Plant (LEMZ), and NIIIP, Novosibirsk.

SA-I 1 'Gadfly' (9M38 Buk-M1)

Type

Short-range, ground-based, solid propellant, theatre defence missile.

Development

The SA-11 'Gadfly' is believed to have begun development in the early 1970s. as a possible follow-on to both the SA-4 'Ganef and the SA-6 'Gainful'. The development programme was run jointly by the Russian Army and Navy, using a common missile and radar but with each service responsible for their own specialist support equipment. The naval version is known as SA-N-7 'Gadfly'. The Russian designator for the missile is 9M38 and it is called Buk-M1. It is not known why the SA-10 'Grumble' missile is called Buk and the SA-11 'Gadfly' missile Buk-M1, as the two missiles are not alike. The Russian name for the total SA-I 1 system is Gang. SA-4 'Ganef entered service in 1967 and was not considered to be easy to maintain. The main tactical shortcomings of the SA-6 'Gainful' system was its reliance on a single-engagement radar vehicle in each battery of four launch vehicles. The combat experience of the 1973 Middle East War accentuated the limitations of the SA-6 'Gainful'. As a result, the former Soviet Ground Forces adopted the SA-8 'Gecko' to supplement the SA-6 'Gainful' in air defence regiments. However, the SA-8 did not have the range of the SA-6 system, so a follow-on was required. The SA-11 'Gadfly' programme aimed to reduce the tactical shortcomings of the SA-6 'Gainful' system by fitting each missile launch vehicle with its own radar, enabling it to illuminate targets independently. The existing vehicle was too small to accommodate the additional weight and size of radar, so a new vehicle had to be found. The new C/X-band engagement radar was designated 'Fire Dome' for the army version and 'Front Dome' for the naval. As a stop-gap until the SA-11 missile was completely developed, the army developed and introduced an interim system designated SA-6B 'Gainful' Mod 1. This used the latest version of the SA-6 missile, with the new SA-11 launch vehicle and associated radar. It was introduced into service around 1977. The problems encountered with the SA-11 missile were eventually solved and the definitive SA-I 1 'Gadfly' system entered service in 1979. It was first seen in Turkestan in 1979, but widespread deployment did not begin until 1982. The naval version designated SA-N-7 'Gadfly' was first deployed on the 'Kashin' class trials destroyer *Provorniy,* prior to its adoption and entry into service on the new 'Sovremenny' class of destroyers in 1981. The naval missile has the designator 9M38 and the complete system is called Shtil.

A modified version of SA-11 was developed and entered service in 1983, to enable the missile to be targeted against surface targets as well as aircraft and missile targets. The modifications were made to the surveillance radar, the missile and the command post. A phased array engagement radar was introduced with upgraded digital processors in 1995.

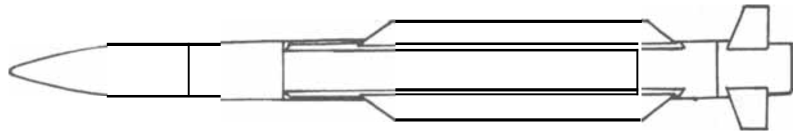
An SA-I I 'Gadfly, 9S18 surveillance radar on its tracked vehicle. exhibited in 1997 (Duncan Lennox)
0044959

An SA-I I 'Gadfly' TELAR vehicle with four missiles raised to the launching position. The TV and laser range-finder assembly can be seen above the engagement radar dome, at the left of the picture (Duncan Lennox)
0044960

In 2000, Agat exhibited an active radar seeker for SA-11 or SA-17 missiles, giving a range of 40 km against fighter aircraft targets. A further system upgrade was reported in 1998, with the designator Buk-M1-2, with an increased range capability by using the SA-17 missile. An improved variant, known in Russia as the Buk-2M or Ural system and in NATO as the SA-17 'Grizzly', entered development in 1987 and became operational in 1994. Further details are given in a separate entry.

Description

The SA-11 'Gadfly' missile is similar in appearance to the US Navy's Standard MR RIM-66 air defence missile. It has four long-chord, short-span wings aft of mid-body and four in-line clipped delta moving control fins on the boat-tail. The missile has an overall length of 5.55 m, body diameter of 0.4 m, fin span of 0.86 m, launch weight of 690 kg and carries a 70 kg high-explosive fragmentation warhead, which is detonated by an RF proximity or contact fuze. Propulsion is by a two phase boost and sustain solid propellant motor which has a burn time of 11 seconds, giving the missile a top speed of 1.2 km/s and maximum range of 35 km. The missile minimum range is 3 km, and it has an intercept altitude envelope of between 15 m and 22 km. Guidance is inertial with command updates in mid-course, using semi-active monopulse radar terminal homing and relies on CW illumination of the target by the 'Fire Dome' engagement radar. The semi-active radar seeker is the Agat 9E50, which has an inertial memory in case of temporary signal loss and a range of 45 km against a fighter aircraft size target. The seeker assembly weighs



A line diagram of the SA-11 'Gadfly' missile

28.5 kg without the radome. The 'Gadfly' reportedly uses a similar flight profile to the US Navy Standard, climbing up and then diving towards the target. An upgraded missile, designated Buk-MI-2, is reported to have a maximum range increased to 45 km and a maximum intercept altitude of 25 km. This version has a range against surface targets of 40 km and uses the same missile used in the SA-17 'Grizzly' system.

Key elements of the SA-11 system are the Command Post (CP) 98470, the surveillance radar vehicle 9S18, the Transporter-Erector-Launcher And Radar vehicle (TELAR) 9A310, the Loader Launcher (LL)9A39 and the missile 9M38 (Buk M-1). All the vehicles are on a fully tracked GM 569 armoured chassis, which is based on a MT-S tractor chassis built by Metrovagonmash at Mytischi. This provides protection from small arms fire and is sealed against NBC attack. The vehicles have a maximum road speed of 65 km/h and a range of 500 km. Each vehicle can be dispersed up to 5 km and if necessary, the TELAR vehicle can operate and launch missiles autonomously. A typical missile battery will have a command post, a surveillance radar, six TELARs, three loader launchers and a total of 48 missiles.

The 9S18 (NATO designation 'Snow Drift') NIIIP surveillance radar, when erected, has an antenna array consisting of a large rectangular 3-D phased array antenna with a smaller rectangular IFF aerial fitted horizontally on top. The antenna rotates through 360° at 6.7, 10 or 18 rpm and covers 0 to 40° in elevation or up to 55° over a limited sector. The 'Snow Drift' is reported to be capable of tracking

A semi-active radar seeker, Agat 9E50, used in the SA-11 missile (Paul Jackson)
0044958

A reload vehicle with two SA-11 missiles (Christopher F Foss)

up to 100 targets, to have a maximum range of 100 km against fighter aircraft targets at altitudes from 1,000 m to 25 krn, and to have a range of 35 km against targets at 100 m altitude. The radar uses frequency agility, clutter rejection, and has a digital processor This radar takes less than 5 minutes to become fully operational after the vehicle comes to a halt. Information is transmitted to the command post vehicle via a radio datalink or landline. The surveillance radar is mounted on a GM-567 tracked chassis, which weighs 35,000 kg and has a crew of three. This vehicle has a 75 kW gas turbine electric power generator. The CP automatically and simultaneously tracks up to 15 of the possible 75 targets from the radar. It then performs a target assessment and allocates the selected targets to the TELARs, which then carry out the engagements. One CP normally controls up to six TELAR vehicles and has six operators.

Each 9A310 TELAR carries four ready to fire missiles on a turntable, which can be traversed through a full 360°. The TELAR also has a 'Fire Dome' monopulse CW 6 to 10 GHz (C/X-band) engagement radar, an IFF and a TV tracker with laser range-finder for use in ECM conditions, which is located on the front of the turntable. A missile up-link, communications and navigation systems are also fitted to the TELAR. The missiles are carried in a horizontal position for travelling and elevated prior to firing. The TELAR has a weight of 32,400 kg when loaded with four missiles. It is reported that the 'Fire Dome' radar is able to lock on to aircraft targets flying at 2,000 m altitude at 85 km, 100 m altitude at 30 km and 20 m altitude at 20 km, with elevations from –10 to +80° in seven steps and azimuth coverage ± 60° from the launcher turntable heading. Normally, two missiles are fired in salvo at each target, with a 3 second interval.

The loader launcher vehicle is similar to the TELAR but without the 'Fire Dome' radar. There are four missiles carried on the normal launcher assembly and four carried in reserve, laid flat on the front of the vehicle in place of the radar. These spare missiles can be transferred to a TELAR as a reload or its own launchers using an onboard crane. The LL can engage targets with an adjacent TELAR providing target information and illumination. Other equipment includes an automated test unit, maintenance and repair trucks and a missile supply vehicle which can carry six SA-11 missiles in their containers, or eight without. It is reported that at regimental level, there is also a vehicle-mounted early warning radar to replace the earlier 'Long Track, but its NATO designation is not known.

SA-11 Gadfly' surface-to-air missile displayed at the 1992 Moscow Air Show (Christopher F Foss)

Operational status

SA-11 'Gadfly' entered operational service in 1979 and this was joined in 1981 by the naval version SA-N-7. There have been reports of SA-11 use to provide low-altitude coverage of SA-5 'Gammon' sites in lieu of the older SA-3 'Goa'. Reports indicate that deployment of SA-11 was slow. This may have been due to problems with the system and the development of SA-17 'Grizzly' would tend to indicate that improvements had to be made. In 1992, it was estimated that there were some 200 SA-11 'Gadfly' units in service in Russia and that SA-11 missile production averaged 500 per year during the 1980s. A surface-to-surface missile capability was added, which entered service in 1983. Tests have been made against both land and sea surface targets, with reported successful firings against parked aircraft at 5 km range and against a small ship at 12 km range. In 1996, it was reported that an SA-11 missile had been successfully fired at a Virazh-1B ballistic missile target, with an intercept at a range of 25 km and an altitude of 15 km. SA-11 'Gadfly' has been exported to Belarus, Finland, India, Poland, Syria, Ukraine and Federal Republic of Yugoslavia. Upgraded missiles, to the Buk-M1-2 standard, were reported to have completed development and entered service in 1998.

Specifications

Length: 5 55 m
Body diameter: 0 4 m
Launch weight: 690 kg
Warhead: 70 kg HE fragmentation
Guidance: Inertial with updates and semi-active radar
Propulsion: Solid propellant
Range: 35 km (Buk-M1), 45 km (Buk-M1-2)

Associated radars
Surveillance radar: 'Snow Drift' (9S-18)
Frequency: n/k
Peak power: n/k
Range: 100 km

Engagement radar: 'Fire Dome'
Frequency: 6-10 GHz (C/X-band)
Peak power: n/k
Range: 85 km

Contractor

It is believed that SA-11 'Gadfly' was designed by the Toropov OKB-134, Tushino. Support is provided now by Vympel, Moscow, NIIP, Zhukovsky, and Novosibirsk Manufacture of the missiles is carried out at the Ulyanovsk Mechanical Plant, and by Dolgoprudny Research and Production Enterprise.

SA-12 'Gladiator/Giant' (S-300V/Antey 2500/9M82/9M83)

Type

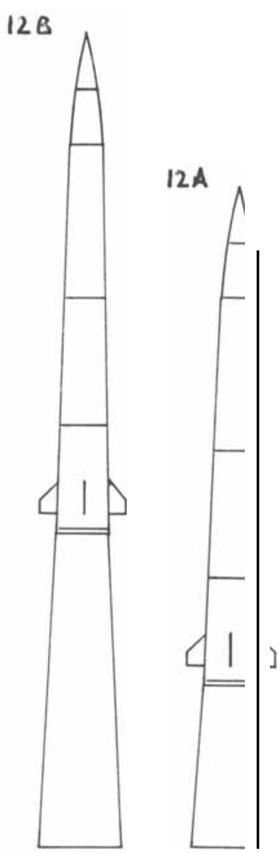
Short- and medium-range, ground-based, solid propellant, theatre defence missiles.

Development

The Russian S-300V SAM system, known to NATO as the SA-12 'Gladiator' and 'Giant', was displayed in public for the first time at the 1992 Moscow Air Show. The Russian designation of S-300 allocated to the SA-10 'Grumble' air defence system has caused confusion with SA-12; there seems to be no direct coupling between any elements of the SA-10 and SA-12 systems, other than that the two systems counter about the same range of threats. SA-10 is a wheeled vehicle system primarily for defence of fixed installations, whilst SA-12 is a tracked vehicle system designed to defend mobile forces. The most likely explanation is that both systems were part of a common programme to address common threat systems, including high-flying bombers, cruise missiles and in particular, the US Lance and Pershing ballistic missiles. The SA-10 system was initially designed against air-breathing threats, whereas the SA-12 was designed from the outset to defend against ballistic missiles. Development is thought to have started in the late 1970s and the SA-12 was designed as a mobile flexible theatre defence system, with two separate missile types that could be used together in mixed fire units. Both missiles are vertically launched and appear to have a common second-stage, but different sized jettisonable booster stages. The 9M82 Type 1 missile is given the NATO designator SA-12B 'Giant' and the 9M83 Type 2 missile is the SA-12A 'Gladiator'. The integration design and production bureau is now the Antey NPO, an amalgamation of companies from the former Soviet Ministry of Radio Industry (MPP). Radar elements of the system were designed by the Kuznetsov OKB, and the missiles were designed by the Novator NPO. The SA-12 was probably designed to counter high-level bomber threats, command and control, airborne early warning, jamming and tanker aircraft as a replacement for SA-5 'Gammon', as well as to intercept ballistic missile targets and cruise missiles at low level. The probable single most important factor in driving such an expensive programme was the introduction of the US Pershing Intermediate-Range Ballistic Missile (IRBM) in the early 1980s. It is believed that the SA-12A 'Gladiator' has been optimised for aircraft and air-to-surface missile interceptions, whilst the larger SA-12B 'Giant' is thought to be optimised to intercept short and intermediate range ballistic missiles. There are reports that both SA-12A and SA-12B missiles have been tested against ballistic missiles and it is possible that SA-12B 'Giant' is also modified to provide better performance against low-flying cruise missiles.

There are believed to be at least three major build standards for the SA-12 system.

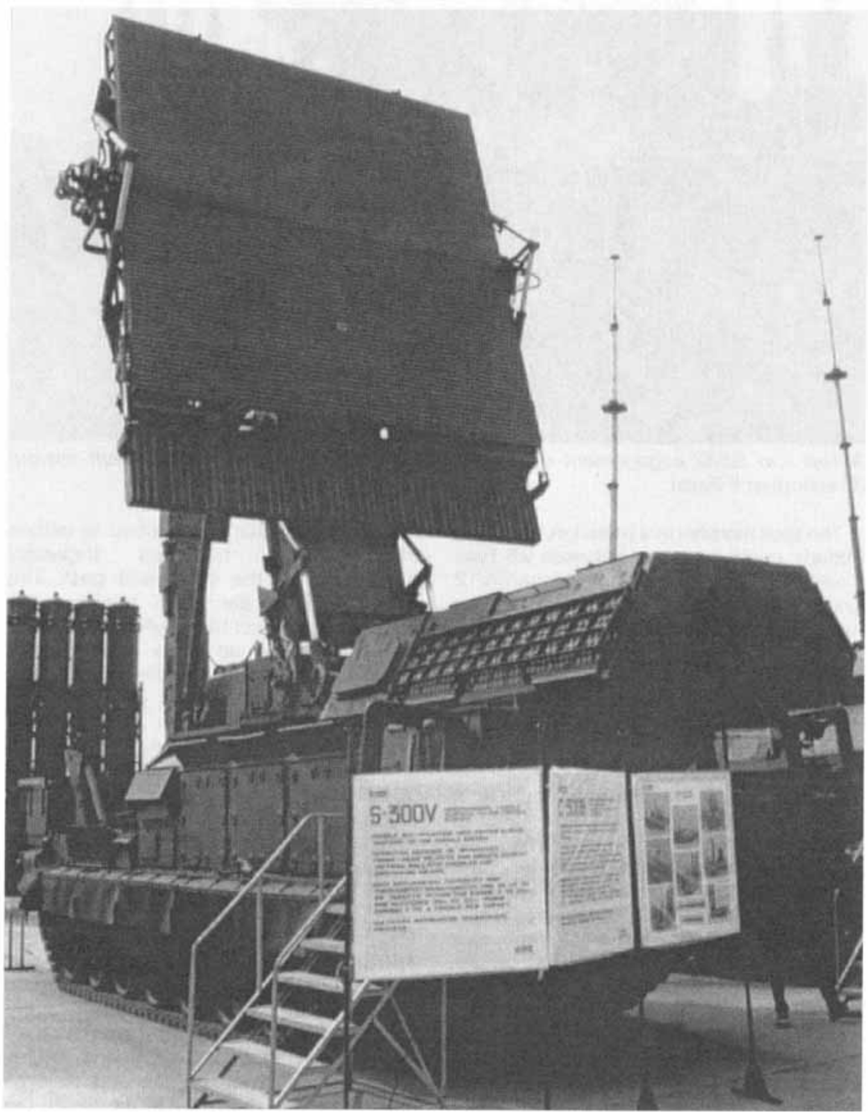
The initial Russian designator was S-300V, an improved version was designated S-300V1 and in 1996, the S-300VM version was reported. The S-300VM system has been offered for export as the Antey 2500. The S-300VM version has modified the SA-12B missile, upgraded the radars, and upgraded the command and control system. This now provides an improved capability against short- and intermediate-range ballistic missiles with ranges up to around 2,500 km, as well as against cruise missiles, fighter aircraft, ECM and AEW aircraft. There have also been reports that the Russians are developing imaging infra-red and active radar seekers that might be



An outline drawing of the SA-12A and SA-12B missiles

In the foreground, an SA-72B Giant TELAR with its two missile launch tubes raised and its radar mast lowered In the background, an SA-12A 'Gladiator' TELAR with its four missile launch tubes and radar mast raised (Christopher F **Foss)**

An SA-12A 'Gladiator, Type 2 missile launch canister alongside a launcher transloader on displayat the 1992Moscow air show (Christopher F Foss)



A 'Bill Board' 9S 15 surveillance radar, part of the mobile SA-12 Gladiator/Giant system (Christopher F Foss)

fitted to a later version of SA-I2B or Antey 2500 missiles, or fitted to a new S-500 theatre missile defence system.

Description

The SA-I2 missiles are large by Western standards, but not when compared to existing Russian Surface-to-Air Missiles (SAMs) such as SA-2, SA-5 or SA-IO for example. Both types of SA-I2 missile are vertically cold-launched from large sealed canisters using compressed air at 1,000 kg/cm², and have a pre-launch delay of 15 seconds. The missiles have a storage life in their canisters of 10 years

The SA-12B 'Giant (Type 1) missile is reported to be 8 5 m long, and weighs around 4,600 kg at launch There are two stages to the missile The first is a jettisonable boost stage, which comprises a solid-propellant motor assembly, this is about 3 35 m long with a tapering shape and a base diameter of 0 9 m The second stage is a missile-type structure, with four control fins at the rear, but with a tapering body section and a base diameter of about 0.56 m. The second stage is estimated to be 5.15 m long, with a 150 kg warhead, and probablyweighsaround 1,500 kg. The warhead is a blast/fragmentation warhead, which directs 15 g fragments towards the target. Data from the ground command post, as well as information from the missile's own guidance and proximity fuzing system, are processed and an optimum solution for warhead detonation is calculated. The fuze has two modes, designed to optimise the engagements against either ballistic missiles or aircraft and cruise missiles. Located through the warhead are a series of detonation cords and by controlling the detonation sequence of these explosive cords, the effectiveness of the warhead is substantially enhanced by directing the fragments into a 60° sector towards the target. It is also believed that there could be a nuclear warhead option. It is assumed that the boost motor, which is jettisoned shortly after the vertical launch sequence, has thrust vector control, as there are no control or stabilising fins fitted to the boost assembly. The second stage has a solid propellant motor that accelerates the missile to a maximum velocity of 2.4 km/s. Control is provided by the four moving fins at the rear of the missile, but it is not known whether this is augmented by TVC or some other control system. The guidance system is similar to that used in the SA-IO 'Grumble' system; inertial with mid-course command updates, followed by a track-via-missile semi-active radar terminal phase. It is reported that an active radar is being developed for the Type 1 missile. The range performance of the SA-I2B 'Giant' Type 1 missile has been quoted as 100 km against aircraft targets with a minimum range of 13 km, and target intercept altitudes of between 250 m and 30 km. The SA-12B Type 1 missile can intercept ballistic missiles to a range of 40 km, with a minimum range of 20 km, and to target altitudes of between 2 and 25 km. SA-I2B missiles can intercept ballistic missiles with peak velocities of 3.0 km/s, equivalent to a maximum range of 1,000 km.

The SA-I2A 'Gladiator' (Type 2) missile is similar in appearance to the Type 1, but not as long. The missile has an overall length of 7.0 m and the boost motor stage is 1.85 m long with a base diameter of 0.72 m. The Type 2 missile is thought to weigh around 2,500 kg at launch. As the second stage is believed to be the same as the one used for the Type 1 missile, it is assumed that the warhead, motor and guidance systems are similar. However, it is reported that the warhead has smaller 2 to 3 gram fragments, and that the missile's maximum velocity is slower at 1.7 km/s. The SA-I2A 'Gladiator' Type 2 missile has

a range of 75 km against aircraft targets and 25 km against short-range ballistic missiles. The Type 2 missile has a minimum range of 7 km, and can intercept targets from 25 m up to an altitude of 25 km.

It is unclear what improvements have been made from the original S-300V to the S-300V1 version of the SA-12 system, but it is believed that small improvements were made to several of the components. It is believed that the capability of the SA-12A (Type 2) missile was improved by the S-300V1 upgrade, and that this missile has a maximum range against aircraft targets increased to 100 km, and against ballistic missile targets to 40 km.

The S-300VM (Antey 2500) version is reported to have a totally redesigned system, with upgraded missiles, radars and command and control equipments. It is unclear if the smaller SA-12 A (Type 2) 9M83M missiles have had any improvements other than for manoeuvrability, but the SA-12B (Type 1) missiles have had major changes made.

The S-300VM Type 1 9M82M missile has a maximum range of 200 km against large aircraft targets, and can engage aircraft or cruise missile threats at altitudes between 25 m and 30 km. Ballistic missile threats with velocities up to 4.5 km/s can now be engaged, equivalent to a range of 2,500 km. Ballistic missiles can be engaged at altitudes between 1 and 25 km, out to a range of 40 km. The warhead fragments have been increased to 20 grams to improve the performance against stronger re-entry vehicle designs. The pre-launch delay for the missile has been reduced to 7.5 seconds.

The composition of a SA-12 battalion consists of two major units. One is the Target Detection and Designation Station, which consists of a 98457 Mobile Command Post, a 9S15 surveillance radar named 'Bill Board' by NATO and a 9S19 sector scanning radar, named 'High Screen' by NATO. The other major unit is the Fire Unit, consisting of four batteries each having: a 9S32 engagement radar/ battery command post (named 'Grill Pan' by NATO); six Transporter-Erector-Launcher And Radar (TELAR), which are a mixture of 9A82 (carries two Type 1 missile canisters) and 9A83 (carries four Type 2 missile canisters) and six transloader vehicles, which are a mixture of 9A84 (carriers two Type 1 missile canisters) and 9A85 (carries four Type 2 missile canisters).

A typical SA-12 battalion will have a command post, surveillance radar, sector scan radar, four battery engagement radar/ command posts, 24 TELAR (mixed between SA-12A and SA-12B), 24 transloader vehicles and about seven additional test and maintenance vehicles. The test and maintenance vehicles have the designators 1R15, 1R17, MTO-80, 9V878, 9V879, 9V848 and 9F88. The TELAR vehicles have a fully loaded weight of 35,000 kg for the SA-12 B 'Giant' (Type 1) and 48,000 kg for the SA-12 A 'Gladiator' (Type 2). with a length of 12.26 m, a width of 3.38 m and a height, when the radars are lowered for transit, of 3.78 m. The SA-12 system is described as mobile, but is unlikely to be air transportable.

A 'Grill Pan 9S32 engagement radar, part of **the** *mobile SA-12 'Gladiator/Giant' system* (Christopher F Foss)

The total missiles in a battalion, including reloads, could be varied between 96 Type 1 and 192 Type 2 missiles. All of the SA-12 system components are mounted on tracked vehicles based on the Type 80 tank chassis, which would seem to indicate that this system was to be used near the forward edge of the battle area. The NIIIP-designed 9S15 mobile surveillance radar, designated 'Bill Board' by NATO, provides regular space scanning of 360° in azimuth and up to 55° in elevation out to a maximum range of 200 km, and a maximum altitude of 30 km. This radar rotates mechanically at 6 to 18 rpm, and elevation can be electronically scanned in different sectors. The 9S15 radar operates in S-band (2 to 3 GHz) using coherent pulse Doppler, and can track up to 200 targets and transmit the data to the command post. This radar is mounted on a 832-tracked vehicle chassis, with a total weight of 47,000 kg, and the vehicle also has a 130 kW gas turbine electrical power generator. The radar has four operator positions. The 9S19 mobile 'High Screen' sector search radar is required to give the SA-12 sufficient reaction time against ballistic missile threats, as these entail much higher velocities than aircraft. The 'High Screen' radar scans electronically at one scan per second, covering a 90° sector in azimuth and 50° sector in elevation having a range of up to 175 km. When a high-speed ballistic missile target is detected, the radar is switched to initiate tracking and transmits trajectory parameters to the command post. The command post can then prioritise the threats and instruct the 'High Screen' radar station to track up to a maximum of 16 specified ballistic missile targets. The 9S457 mobile command post provides control of the total system, track initiation and tracking of up to 70 targets, distributing up to 24 aircraft targets or 16 ballistic missile targets automatically among the four battery fire units. Each mobile 9S32 'Grill Pan' radar tracks the designated targets, controls the operation of six launchers and transmits necessary data for missile launching and guidance. This radar has a maximum range of 150 km. The 'Grill Pan' radar also performs a horizon search, where low-altitude targets are likely to appear. Each of the 9A82 and 9A83-1 TELARs have their own target illuminating and command radars, which are mounted on the end of large folding masts. On the 9A83 (Type 2). the radar has a 360° coverage in azimuth, as well as full hemispheric coverage in elevation. The 9A82 (Type 1) radar is semi-fixed, with 90° coverage to either side and 110° in elevation. The system fires either one or two missiles at each target from the same launcher vehicle, or can fire up to four missiles at a single target from two launchers. The missiles from a single launcher vehicle can be fired within

1.5 seconds of each other in salvo. Missiles can also be fired from the transloader vehicle, with an adjacent TELAR providing target information and illumination. It is reported that the SA-I2 system's missile launch vehicles can be ready to fire within 5 minutes of reaching a pre-surveyed suitable firing site, whilst the launch vehicles are said to require 5 minutes after launch to be on the move again.

The S-300VM (Antey 2500) system has upgraded mobile command post, surveillance radar, sector scan radar and engagement radars and improved communications. The 9S15M2 surveillance radar (Obzor 3) range has been increased to 300 km. The 'High Screen' sector scan radar has been upgraded to the 9S19M standard, which has an X-band phased array antenna, 4 × 3 m in size with either 7 or 13 beams. This radar can track up to 20 targets and can detect a re-entry vehicle at 120 km range. The 9S32M engagement radar has been upgraded with improved range and ECCM. The two TELARs have been upgraded to 9A82M and 9A83M, and can launch salvo missiles at intervals of 1.5 seconds.

Reports indicate that the Russian air defence command and control systems Baykal I and Senezh-MI can be netted to integrate between 15 and 20 SAM system batteries and share target allocation. It is believed that SA-5, SA-IO and SA-I2 systems can be integrated with fighter aircraft, covering a front-line of around 600 km. An improved mobile command post, called Polyana-D4M and designated 9S52M, was reported in November 2001. This has been developed by Radiozavod at Penza, and provides 7 operator stations in a 6 × 6 wheeled truck with A-50 computers and a VHF/UHF communications suite with GPS/Glonass in a towed trailer. The command post can be used with the S-300MV system, and provides 250 displayed targets, with up to 120 aircraft and 20 ballistic missile targets.

Operational status

The SA-12A 'Gladiator' system is believed to have entered service in 1983. By 1991, official US sources placed SA-I2 'Gladiator' strength at 100 launchers. The SA-12B 'Giant' entered service in 1986 and there are unconfirmed reports that it may be deployed with the rail mobile SS-24 'Scalpel' and road mobile SS-25 'Sickle' ICBMs. In 1993, two sets of trials were reported, with SA-12 missiles successfully intercepting 'Scud B' missile targets and other 'Scud' type targets modified to represent the 'Scud C' and Al Hussein 550 km range ballistic missiles. In 1995, successful trials were reported against short-range ballistic missile targets (the 120 km range Virazh-1B), with intercepts at 40 km range and an altitude of 20 km and against 900 km range targets believed to be similar to SS-12 'Scaleboard' missiles. In 1997, the Russians reported that over 60 trials firings had been made with SA-12 missiles against ballistic missile, cruise missile and aircraft targets.

There are conflicting reports about the S-300VM system. One report suggests that the system entered service in 1996, and another report says that the system has been developed and offered for export, but has not been purchased by the Russian Federation. The S-300VM (Antey 2500) system has been tested against modified SS-4 'Sandel' target ballistic missiles, with a range of 2,000 to 2,500 km and also against two Tu-I6 'Badger' drone aircraft with successful intercepts at a range of 200 km. The SA-12 system was first displayed and offered for export in 1992 and has been exported to Belarus and Ukraine. Some missiles are reported to have been deployed in Armenia in 1999, as part of an integrated air defence system for the Russian Federation and partner countries. An unconfirmed report suggests that the USA purchased part of a fire unit in 1995, for comparative testing. India is reported to have ordered six battalions of SA-12s in 1998, for integration with the Indian Akash medium-range SAM system.

In August 2001 it was reported that India would purchase six battalions and manufacture (or assemble and test) a further 19 battalions of Antey 2500 systems under licence.

Specifications

SA-12A 'Gladiator'
Length: 7.0 m (with booster)
Body diameter: 0.72 m (with booster)
Launch weight: 2,500 kg
Warhead: 150 kg HE or nuclear
Guidance: Inertial with updates and semi-active radar
Propulsion: Solid propellant
Range: 75 km (S-300V), 100 km (S-300V1)

SA-I2B 'Giant'
Length: 8.5 m (with booster)
Body diameter: 0.9 m (with booster)
Launch weight: 4,600 kg
Warhead: 150 kg HE or nuclear
Guidance: Inertial with updates and semi-active radar
Propulsion: Solid propellant
Range: 100 km (S-300V), 200 km (S-300VM)

Associated radars
Surveillance radar: 'Bill Board' 9S15
Frequency: 2-3 GHz (S-band)
Average power: 7 kW
Range: 200 km (S-300V), 300 km (S-300VM)

Sector radar: 'High Screen' 9S19
Frequency: n/k
Average power: n/k
Range: 175 km

Engagement radar: 'Grill Pan' 9S32
Frequency: 8-10 GHz (X-band)
Peak power: n/k
Range: 150 km

Contractors

Antey NPO, Moscow, (prime contractor).
NIIIP, Novosibirsk (radars).
Novatur NPO, Yekaterinburg (missiles).

SA-I5 'Gauntlet' (9M330 Tor/9M331 Tor-M1/9M317)

Type
Short-range, ground-based, solid propellant, theatre defence missile.

Development
The joint development of SA-I5 'Gauntlet' and SA-N-9 is the third example of Russian joint land- and ship-based surface-to-air missile systems programmes, and presumably indicates satisfaction with earlier such programmes for the SA-8 and SA-N-4 'Gecko' and for the SA-I0 and SA-N-6 'Grumble' systems. SA-I5 and SA-N-9 development was lead by Antey NPO, and took place in the late 1970s and early 1980s. The system appears to have been designed to a requirement to produce a vertically launched missile with the capability to intercept sea-skimming missiles and low-flying cruise missiles to replace the SA-8 'Gecko' and SA-N-4 'Gecko' systems.

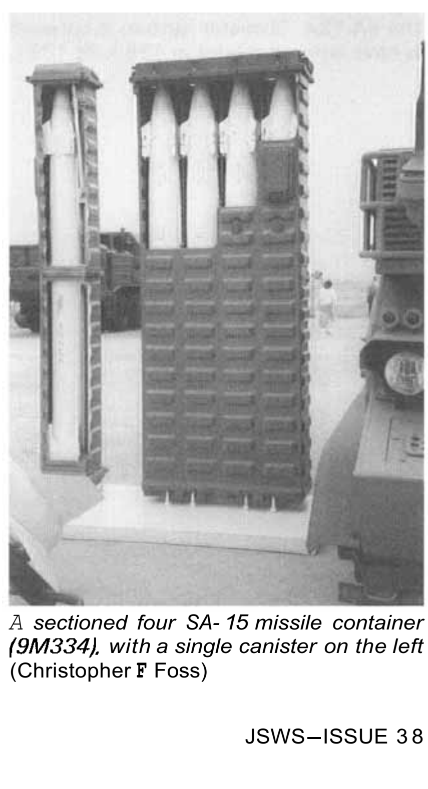
In late 1990, details were released of the Russian 9K330 Tor SAM system, which carried eight vertically launched SA-I5 missiles (Russian designator 9M330). This, the world's first mobile land-based air defence system to use vertically launched missiles, was mounted on a single tracked chassis almost identical to the 2S6 system (SA-I9).

In 1991, an improved phased-array radar and upgraded 9M331 missile was added and this system was designated 9K331 Tor-MI. This improved system was capable of intercepting two separate targets at the same time. The Tor system has been marketed by both Fakel MKB and by the Research and Production Association Antey. It is believed that the Fakel MKB incorporates both the Grushin and Bunkin OKBs. Grushin OKB is reported to have designed SA-3 'Goa', SA-5 'Gammon', SA-8 'Gecko' and part of the SA-IO 'Grumble' SAM systems. Antey NPO participated in the design of SA-4 'Ganef' and SA-8 'Gecko' SAM systems. The Tor SAM system has been deployed with the SA-I0 'Grumble' system to provide a more complete air defence system against low-flying fixed-wing aircraft, helicopters, RPVs, laser guided bombs and guided missiles around high-value targets. In 1999 the IEMZ-Kupol State Enterprise were advertising the manufacture of the SA-I5 system, together with Antey NPO.

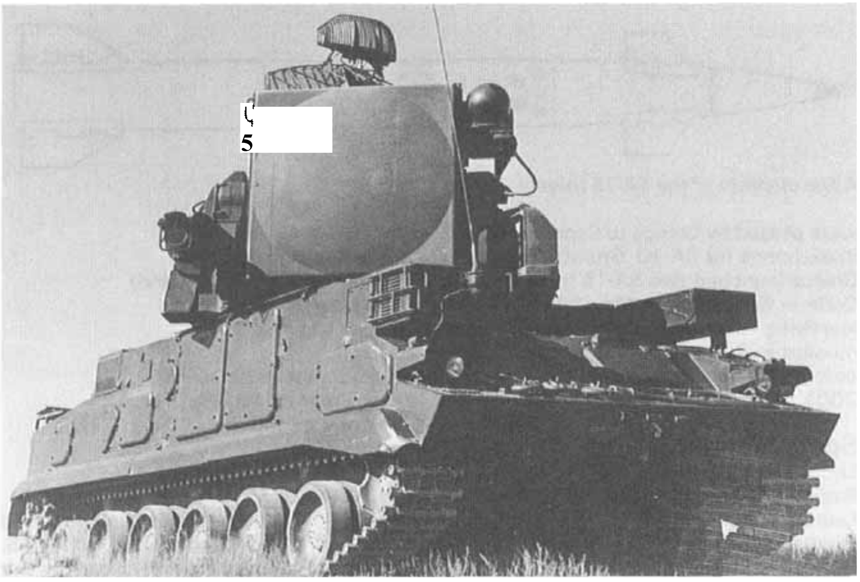
In 1996, SA-I5 system components were offered for export on a variety of wheeled vehicles or in air-transportable containers. A trailer-mounted version carries eight missiles and is towed by a 6 × 6 wheeled tractor that also houses the fire-control unit and crew. Fakel MKB showed an active radar-guided variant of the SA-I5 missile as a potential air-to-air missile in 1996, but a new design missile has now been used for the 9M96 Trieumf system, which is described in a separate entry. In 1999 modifications were offered to SA-I5 systems for export. These included increased range, flight speed and altitude for the missile, more missiles to be carried in the TELAR vehicle and a self-loading system for the TELAR. In addition, alternative wheeled vehicle and towed or static container versions of Tor-MI were also advertised, providing lower cost and easier air transportation. The wheeled vehicle version uses a modified Ural-5323 truck for the TELAR, with a weight of 30,000 kg and this is designated Tor-M1TA. A towed, wheeled version with a truck-mounted control cabin with a weight of 16,000 kg and a trailer TELAR weighing 14,000 kg, is designated Tor-M1TB.

A Ranzhir battery command post vehicle (9S 737) 0081833

SA-15 'Gauntlet' SAM system with its rear surveillance radar antenna raised. shown at Moscow in 1992 (Christopher F Foss)



A sectioned four SA-15 missile container (9M334), with a single canister on the left (Christopher F Foss)



The SA- 15 'Gauntlet' TELAR vehicle, with its phased-array engagement radar and TV camera system on the front of the turret assemblv

A static container version, with a weight reduced to 10,000 kg, has the designator Tor-M ITS. A further missile modification, designated 9M337, has been introduced, but it is not known what improvements were included with this version.

In 2001 an automated command and control system was offered for export, specifically to defend high-value targets from precision-guided bombs and ASM.

Description

The vertically launched SA-15 missile has four folding clipped delta control fins at the nose and four folding in-line clipped delta-wings at the rear. The missile is 2.9 m long, has a body diameter of 0.24 m and a launch weight of 167 kg. It carries a 15 kg high-explosive fragmentation warhead which is activated by RF proximity or contact fuze and is capable of being directed at the target by the proximity fuze. A solid propellant motor gives the missile a maximum speed of 850 m/s. The missile has a probable range against low-level missile targets of 5 km and of 12 km against aircraft targets. The minimum engagement range is 1 km. Altitude engagement limits are 10 m to 6 km. The missile is ejected from its launch canister to a height of 18 to 20 m before the two-stage solid propellant motor is ignited, with the 'turn-over' of the missile controlled by lateral thrust motors in the nose of the missile. The solid propellant motor can have two separate burning periods if required, to shape the trajectory and increase terminal velocity. The normal boost stage lasts 4 seconds and the sustain stage 12 seconds, giving the missile powered flight out to about 8 km range depending on the trajectory shape. The lateral thrust motors are also used in the terminal engagement phase to improve missile manoeuvrability. The missile is advertised as having command-guidance, which operates with a coded datalink, but in order to intercept missile targets it would require an active radar terminal seeker and it is believed that a later modification has an active radar seeker. The missiles have a 10 year life in their canisters.

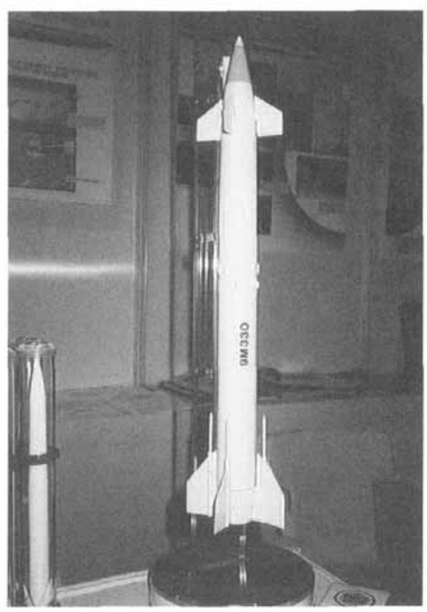
The Tor TELAR vehicle, a modified GM 5955 tracked vehicle (Russian designator 9A331) also used with SA-I 1 'Gadfly', carries eight SA-I5 missiles mounted vertically in two groups of four, each group in a sealed container. The vehicle has a V12 diesel engine, and a gas-turbine engine driving a 75 kW electric generator. The TELAR is 7.5 m long, has a width of 3.3 m, a height of 5.1 m with the radar raised, and a total weight of 37,000 kg. The vehicle has a combat crew of three and can be in action within 3 minutes of coming to rest. The TELAR has a maximum road speed of 65 km/h and an unrefueled range of 500 km. The three-dimension rotating pulse Doppler surveillance radar, mounted on the rear of the turret, has eight beams that can be switched between a low elevation from 0 to 32" and a high elevation between 32 and 64°. The radar antenna rotates at 60 rpm. It operates at 4 to 6 GHz (C-band) and provides range, azimuth, elevation and automatic threat evaluation for up to 48 targets to a maximum range of 40 km and a maximum altitude of 23 km, initiating the tracking of up to 10 targets. The early Tor TELAR had an open mesh antenna for the engagement radar, but by 1992, a phased-array radar was being displayed and reported as being designated as the Tor-M1 system. Additional long-range surveillance is sometimes provided by a 'Dog Ear' radar, which operates between 3 to 6 GHz (C-band), has an acquisition range of 80 km and is used with SA-I 3 'Gopher'. A phased-array, monopulse Doppler engagement radar is mounted on the front of the turret. This operates in the K-band at 20 to 40 GHz, has a maximum range of 25 km and is capable of simultaneously tracking and initiating attacks on two targets. A small dome-type antenna on the top left of the tracking radar gathers the missile as it is launched and hands it over to the tracking radar. The TELAR has an IFF system. An autonomous TV engagement system, complementary to the radar, enables the system to operate in battlefield clutter and ECM environments. This has a range of 20 km.

Target surveillance is executed on the move, but the TELAR vehicle would have to come to a halt for missile launching Two missiles can be fired in salvo at 3 second intervals, at each target and a single launch vehicle can fire at four targets simultaneously, provided that the targets are within a 60 × 60° sector. The Tor SA-15 is air-transportable and has a datalink enabling it to be used in conjunction with other air defence control systems, as part of a larger overall network A reload vehicle (Russian designator 9T244) carries eight missiles in canisters and has a crane attached, enabling the complete reload of a Tor TELAR vehicle in 18 minutes; this vehicle is a modified Ural-4320 truck with a loaded weight of 13,750 kg. A reload transporter (Russian designator 9T245) carries a further 28 missiles.

A command and control vehicle mounted on a tracked GM-5965 chassis, known as Ranzhir (Russian designator 98737). controls a typical SA-I5 battery comprising four to six TELAR vehicles, a reload vehicle, reload transporter, maintenance vehicle (9B887M) and a test system vehicle. An upgraded Ranzhir, 9S737MC2, has been developed by Radiozavod at Penza. This has five operator stations, IFF, GPS/Glonass, HF, VHF and UHF communications and a driver's night vision aid. The vehicle has a length of 8.4 m, width of 3.26 m, height of 3.05 m and a weight of 31,000 kg. The datalink range is 30 km, and launchers can be located up to 5 km away. A truck-mounted simulator and training vehicle (Russian designation 9F678) has also been deployed with some batteries.

Operational status

The SA-N-9 system entered service in 1984 and it is thought that the SA-I5 followed in 1986. The Tor-M1 upgrade entered service in 1991. A small number of Tor-M1T systems were delivered in December 2000, believed to be five systems for operational evaluation. SA-15

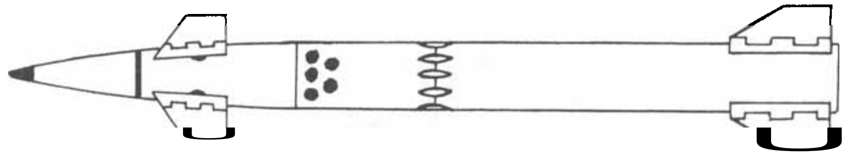


An SA- 15 Gauntlet surface-to-air missile, on display at Paris in 1995
(Peter Humphris)

'Gauntlet' is replacing both SA-6 'Gainful' and SA-8 'Gecko' systems in Russian service. In 1995, it was estimated that around 300 launchers were in service, and it is believed that by 2001 there were 350.

The 'Tor' SAM system with SA-I5 missiles was offered for export by the Russians in late 1990 and it is believed that export orders have been placed by Belarus, China, Greece, India, Iran, Peru and Ukraine. China is reported to have ordered 15 batteries in 1995 and a further 20 batteries in 1998.

In March 2000, it was reported that China has a licensed production agreement to build up to 160 launchers and missiles to an improved standard, with the Chinese designation HQ-17. The Chinese plan to have ten regiments of SA-I5, with 16 launchers per regiment, and conducted 12 flight tests in 2000. Greece ordered 21 launchers and seven Ranzhir command post vehicles in 1998, to be fitted with a NATO IFF system, and ordered a further ten launchers and four command posts in 2000. Six launchers were passed by Greece to Cyprus in 2000, in exchange for SA-IO 'Grumble' systems. Greece launched two SA-I5 missiles from Crete in firing trials in May 2000, against low-flying UAV targets, and a further four missiles in 2001. Iran is reported to have ordered Tor-MI and Tor-M1T in March 2001.


A line diagram ***of the*** *SA-15 missile*

Specifications

Length: 2.9 m
Body diameter: 0.24 m
Launch weight: 167 kg
Warhead: 15 kg HE fragmentation
Guidance: Command
Propulsion: Solid propellant
Range: 12 km

Associated radars
Surveillance radar: n/k
Frequency: 4-6 GHz (C-band)
Peak power: n/k
Range: 40 km

Engagement radar: n/k
Frequency: 20-40 GHz (K-band)
Peak power: n/k
Range: 25 km

Contractors

The SA-I5 (Tor system) has been designed by Antey NPO, Moscow and Fakel MKB, Khimky. It is being manufactured by the IEMZ-Kupol State Enterprise, Izhevsk.

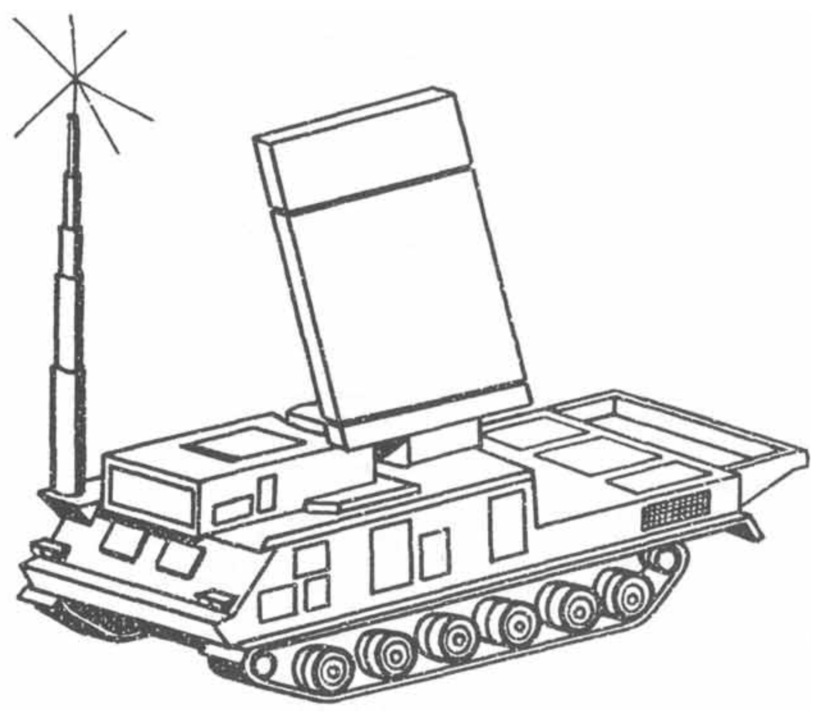
SA-I7 'Grizzly' (Ural/Buk-2M, 9M38M2/9M317)

Type
Short-range, ground-based, solid propellant, theatre defence missile.

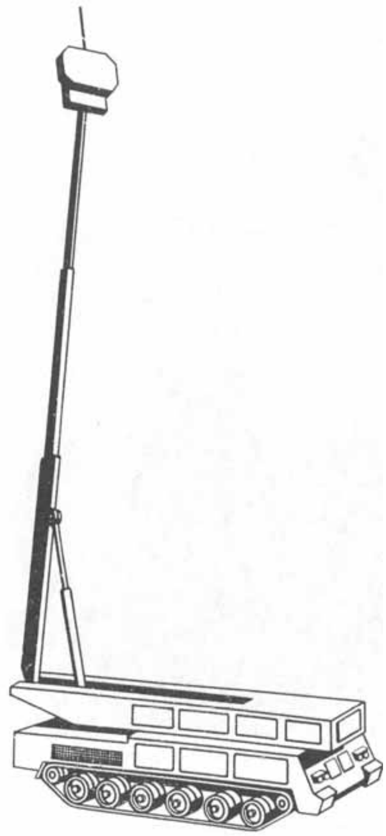
Development
SA-I7 'Grizzly' is an upgraded variant of SA-I 1 'Gadfly', with development probably starting around 1987. The system was developed by Vympel NPO, with support from NIIIP and NIIP, building on their joint experience with SA-I 1. SA-I 7 'Grizzly' has the Russian designator Ural for the complete land-based system. The upgraded SA-11 missile, designated 9M38M2, can be used with the SA-I7 system. An improved missile, with the designator 9M3 17, was developed specifically for the SA-I7 system. This SAM system has been designed for use against aircraft, hovering helicopter, tactical ballistic missile, cruise missile, air-to-surface missile and UAV targets. It may also have a capability against surface targets, as for the improved SA-I 1 system. There are similarities between the SA-I 1 and SA-I7 missiles and the US RIM-66 Standard. The SA-I7 missile also bears a resemblance to the Vympel R-37 air-to-air missile. It is believed that a naval version of the SA-I7 missile (called Yozh) has been developed for the later 'Sovremenny' class destroyers (type 956A), with the NATO designator SA-N-12, and that this system is known as Shtil-1 or Smertch in Russia.

A model of the SA-7 7 Grizzly TELAR vehicle exhibited in 7993 showing four missiles and the engagement radar Chair Back A' (Steve Zaloga)

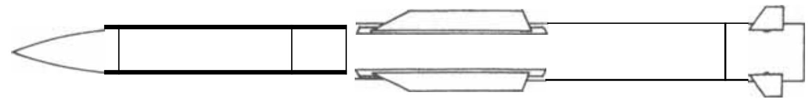
Unconfirmed reports suggest that a further improvement to the SA-I7 missile is now in development, with delta-wings for improved manoeuvrability against low-level targets, and that this missile system will be known as Mysk. In 1995, a new version of the SA-I7 system was displayed for export, with the system components mounted on wheeled vehicles in place of the original tracked vehicles. The launcher was an articulated vehicle, with four missiles on its rail launchers and four reload missiles in front. It is reported that the engagement radar has improved digital processors, enabling 10 to 12 intercepts and providing further ECCM. The surveillance radar and command and control vehicles were also mounted on semi-trailers. In 1997, a hybrid SA-I 1/SA-I7 system, designated Buk MI-2, was exhibited with the ability to use the SA-I7 missiles (9M317) from the SA-I 1 launcher and operating system. In 2000, Agat were reported to be developing an active radar seeker for the SA-I7 missile, with a range of 40 km against fighter aircraft targets.


A line diagram of the SA-I 7 modified 'Snow Drift' surveillance radar vehicle

Description
The SA-I7 missile (9M3 17) is 5.5 m long, has a body diameter of 0.4 m and a launch weight of 715 kg. A 70 kg high-explosive fragmentation warhead is fitted, but there is an option for a 50 kg warhead, which is probably an aimable HE warhead. The SA-I7 missile is similar to the SA-I 1 (Buk-MI) but has shorter chord wings with a span of 0.86 m, is 30 kg heavier and has a longer range. Propulsion for SA-I7 uses an integrated boost/sustainer solid-propellant motor that provides the missile with a peak velocity of 1.23 km/s, and a maximum range of 42 km against a fighter aircraft target. The maximum range against SRBM is 20 km, at altitudes between 2 and 16 km. Against small RCS cruise missile, ASM or UAV targets the maximum range varies between 20 and 26 km, at intercept altitudes between 30 m and 6 km. The maximum range against a hovering helicopter is 42 km. The minimum range is 3 km. For use against surface targets, SA-I7 has a range of 18 to 25 km against ships, and 12 to 15 km against land targets. Guidance in mid-course uses inertial plus command updates and in the terminal phase uses a semi-active radar seeker. The missile has a storage life of 10 years and the TELAR has a readiness time of 5 minutes. The system readiness time is increased to 15 minutes if the telescopic engagement radar is used. Salvo firings from the same launcher can be made at 4 second intervals and the engagement radar can handle four simultaneous engagements against separate targets.



A line diagram of the SA-17 engagement radar Chair Back B', with the antenna raised to a height of 21 m to illuminate low-flying targets



A line diagram of the SA-17 'Grizzly' missile

A line diagram of the SA-17 command and control vehicle

Modified SA-11 missiles, designated 9M38M1/2, can be used with the SA-17 system if required.

The SA-17 'Grizzly' TELAR is a modified 9A310M1/2 TELAR from the SA-11 system, using the GM-569 tracked vehicle. The TELAR has four missiles on a rotating launcher assembly and a phased-array engagement radar known in NATO as 'Chair Back A. The total weight of the vehicle is 35,000 kg. It has a road speed of 70 km/h and a range of 500 km. The 'Chair Back A radar has a range of 60 km, and scans ±60° in azimuth and from –5 to +85° in elevation; the radar can control four separate engagements, has a command uplink to the missile and an IFF interrogator. A separate EO tracker and laser range-finder can be used in ECM conditions. The TELAR vehicle also has a navigation system, believed to be GPS, and an engagement simulator for crew training. The launcher/loader vehicle carries four missiles on launch rails, a further four missiles as reloads and has a hydraulic crane fitted. A set of four missiles can be reloaded onto the TELAR vehicle in 15 minutes. The launcher/loader vehicle can also be used as a remote launcher, controlled by a TELAR. The tracked vehicle weighs 38,000 kg and the wheeled version weighs 35,000 kg.

A new development for the SA-17 system is a separate engagement radar known in NATO as 'Chair Back B'. This radar is similar to that on the TELAR, but is mounted on a separate tracked or wheeled vehicle with a telescopic arm to raise the antenna to a height of 21 m to acquire and track very low-level targets.

A NIIIP surveillance radar, a modified 9S18M1/2 'Snow Drift' 3-D phased-array radar from the SA-11 system, can be mounted on either a tracked GM 567 chassis or wheeled vehicle. This coherent pulse Doppler radar scans mechanically in azimuth through 360° at 6 to 18 rpm, and electronically steers the beam from 0 to 50° in elevation. This radar has frequency agility, clutter rejection and advanced ECCM. It has a range of 100 km against a fighter target, and can track up to 100 targets. The tracked vehicle weighs 35,000 kg, has a 75 kW gas turbine electrical power generator, and carries a crew of three operators. The wheeled version weighs 30,000 kg.

Each SA-17 battery has a command and control vehicle, a surveillance radar vehicle, four TELARS and four loader/launcher vehicles. The command and control vehicle is similar to the 9S470 used by the SA-11 system, but with the SA-17 can be either tracked or wheeled. The tracked vehicle weighs 30,000 kg and the wheeled version weighs 25,000 kg. The command system can track 260 targets and can control up to six TELARS and up to 36 engagements.

Operational status

Development of the SA-17 'Grizzly' system is believed to have begun in 1987 and it is believed to have entered service in 1998. However, reports from Russia suggest that only an early production batch was manufactured and that full-scale production did not start until 1998. It is reported that the naval version, SA-N-12 'Grizzly', entered service in 1993, fitted into the last four 'Sovremenny' class (Type 956A) destroyers, although the improved 9M317 missiles may not have been available until 1998. The SA-17 system was offered for export in 1993. A further improved missile is reported to be in development. In February 2001 it was reported that India was planning to order SA-17 missile systems, but this has not been confirmed.

Specifications

Length: 5.5 m
Body diameter: 0.4 m
Launch weight: 715 kg
Warhead: 70 kg HE fragmentation or 50 kg HE
Guidance: Inertial with updates and semi-active radar
Propulsion: Solid propellant
Range: 45 km

Associated radars
Surveillance radar: Modified 9S18M1 'Snow Drift'
Frequency: n/k
Peak power: n/k
Range: 100 km

Engagement radar: 'Chair Back A/B'
Frequency: n/k
Peak power: n/k
Range: 60 km

Contractors

Vympel State Machine Building Design Bureau, Moscow, with support from NIIIP, Novosibirsk and NIIP, Zhukovsky. It is believed that the earlier SA-11 missiles were built at the Ulyanovsk Mechanical Plant, and that the later SA-17 missiles are built by Dolgoprudny Research and Production Enterprise.

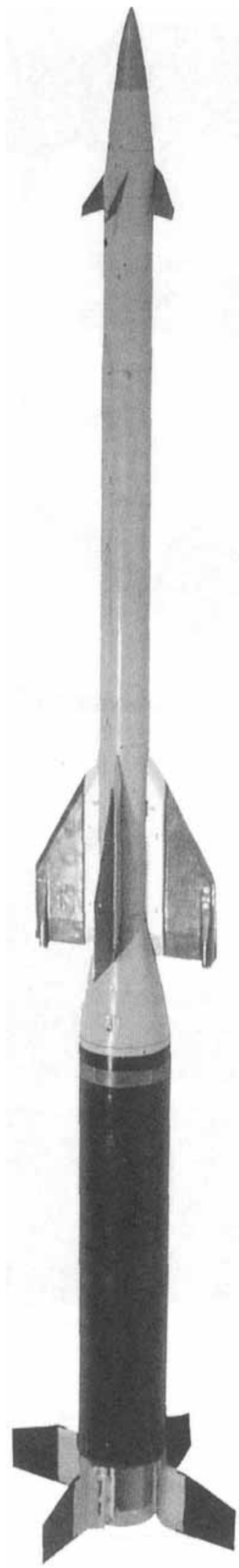
SA-I9 'Grison' (9M311 Tunguska/9M335 Pantsir-SI 57E6)

Type
Short-range, ground-based, solid-propellant, theatre defence missile.

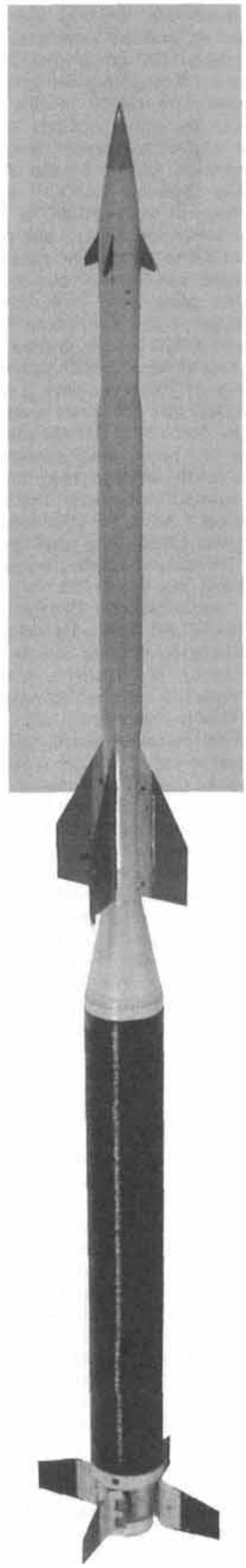
Development
Russia developed a tube-launched low-altitude missile, designated SA-19 'Grison' by NATO, for use on the 2S6 Air Defence Gun/Missile System, which the Russians called 'Tunguska' or 2K22 Treugolnik. It was designed as a replacement for the ZSU-23-4 'Shilka' for use against low-flying aircraft, helicopters and air-to-surface missiles. It is believed that the system also has a secondary capability against armoured fighting vehicles and similar ground targets. This programme appears to have been a joint Soviet Army/Navy development. The 2S6 system was first identified in 1986 and was given the NATO/STANAG codename SPAAG M-1986. The Tunguska system armament consists of two twin 30 mm cannon with 1,900 rounds of ammunition and eight SA-I9 missiles that have the Russian designator 9M311. The SA-I9 missile has also been developed as a Russian naval close-in weapon system, given the NATO designation SA-N-11 and called Kortik (Kashtan for the export version) by the Russians. It has been seen on the *Kalinin,* the third of the 'Kirov' class battle cruisers.

An improved version of SA-I9 was exhibited in 1993, known in Russia as the Pantsir-S1 system, with a larger missile (designated 9M335 or 57E6) and a range increased to 12 km. A further upgrade was exhibited in 2000, with a maximum range increased to 20 km and designated 57E6Y. The Pantsir-SI system is mounted on an 8 × 8 wheeled truck, with 12 missiles and two cannons (30 mm), but has also been offered for export on a tracked chassis or as a shelter version.

Description
The SA-I9, Tunguska 9M311 version, is a tube-launched missile. It is 2.63 m long, with a boost motor body diameter of 0.152 m, a second stage (sustainer motor) body diameter of 0.076 m and a launch weight of 42.0 kg. The missile in its canister weighs a total of 60 kg. The missile has a two-stage solid-propellant motor, with the first tandem boost motor jettisoned, giving a maximum velocity of 900 m/s and a range of 10 km. The eight missiles are contained in two groups of four canisters, and are located outboard of the gun systems. The missiles are radio-command-guided, with manual track of the target and automatic missile track and missile guidance commands. A pulsed light source is located on the rear of the missile to assist with tracking. SA-I9 has a 9 kg HE expanding rod warhead, with an active laser proximity fuse. The Tunguska system has two separate radars; at the front of the turret is the circular antenna of the engagement radar used to track the target and direct the gun and at the rear, is a parabolic antenna for the surveillance and target acquisition radar, called 'Hot Shot'



A Tunguska 9M311 missile (KBP) 0010172



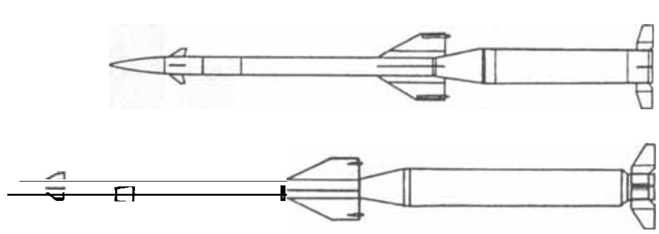
A Pantsir-S1 missile (KBP) 0010178

by NATO. The two radars are supplemented by an electro-optical system, which is believed to include a thermal imaging sight, TV system, laser range-finder and laser designator. It is thought that the EO system can be used for passive surveillance, tracking and target designation, as well as augmenting the radars in heavy ECM conditions. The EO system has a × *8* magnification and an 8" field of view. The SA-I9 missile could provide the Tunguska system with a secondary capability against armoured fighting vehicles, similar to the ADATS system The Russians quote a system reaction time of *8* seconds, a target acquisition range of 18 km and missile ranges from 2.5 to 10 km. The missile can engage targets between 10 and 3,500 m altitude. The guns used with the 2S6 system are two 2A38 twin-barrel 30 mm cannon, with 1,904 rounds carried and a maximum rate of fire of 2,500 rounds/min from each gun. The guns have a muzzle velocity of 960 m/s and have a range of O 2 to 4 km. The 2S6M TELAR vehicle is based on a new medium-armoured transporter family, evolved from the MT-S armoured tracked transporter. The TELA!? has a length of 7.93 m, a loaded weight of 34,000 kg and a maximum road speed of 65 km/h. The same vehicle chassis has been used with the SA-I 1 'Gadfly', SA-I5 'Gauntlet' and SA-I7 'Grizzly' SAM systems. The TELAR for SA-I9 has a crew of four and is reported to be able to fire on the move at up to 45 km/h. A typical Tunguska battery is reported to include six tracked TELAR vehicles, six 2F77 transporter and reload vehicles, two repair and one test vehicle. The system has a reported reload time of 16 minutes.

The SA-I9 'Grison' Pantsir-SI version started in development in 1992 and incorporates a larger missile (designated 9M335 or 57E6) on a wheeled TELAR vehicle. A tracked TELAR vehicle, and a shelter version have also been developed The Pantsir-SI missile is 3.2 m long and has a two-stage, solid-propellant propulsion system. This consists of a separating boost motor assembly with a body diameter of 0.17 m and a second stage (sustainer motor) with body diameters of 0.09 and 0.07 m. The missile has a maximum velocity of 1 1 km/s, weighs 65 kg at launch and 90 kg including its canister. The warhead is a 16 kg HE rod/fragmentation type. Guidance is by command to line of sight, controlled automatically by either a dual-frequency radar or a long wave I!?sensor. The Pantsir-SI missile has a minimum range of 1.0 km, a maximum range of 12 km and is able to engage targets from 5 m to 10 km altitude. The TELAR vehicle is an *8* × *8* modified Ural 53234 wheeled truck, with a crew of three and weighs 20,000 kg fully loaded. The TELA!? may have the Russian designator 96K6. It carries a VN!IRT Shlem surveillance radar operating at 4 to 6 GHz (C-band), two Phazotron engagement radars believed to operate at X-band (8 to 12 GHz) and K-band (20 to 40 GHz) and a long-wave I!?sensor (8 to 14 µm). The Shlern surveillance radar can track 30 targets with a maximum range of 30 km, and the engagement radars can track 24 targets out to a range

A Pantsir-S1 second-stage missile, displayed in 1997 (Duncan Lennox) 0010175

A 2S6 Tunguska Air Defence Gun/Missile System showing four of the SA- 19 'Grison' missile launch canisters, a 30 mm cannon and the two radar antennas (Christopher F Foss)



Line diagrams of the Tunguska (upper) and Pantsir-S1 (lower) missiles 0054263

of 25 km. The radar and IR sensors can command two missiles separately towards the same target and the Pantsir-SI system can control three missiles simultaneously.

The TELAR carries 12 missiles in canisters plus two 2A38 cannons (30 mm), with 1,400 rounds and a firing rate of 2,500 rounds/min per gun. The guns have a range of 200 m to 4 km, and can be used against targets up to 3 km altitude. It is reported that a downgraded, EO-guided only, system may be offered for export.

In 2000, an upgraded version of the Pantsir-SI missile, designated 57E6Y, was exhibited. This missile has a heavier warhead with a weight of 20 kg, and a total launch weight of 74 kg. With improved motors, this version has a minimum range of 1 km, a maximum velocity of 1.3 km/s and a range increased to 20 km. However, the intercept altitude has been reduced to 8 km. The 57E6Y missile has a 3.2 m long canister, with a loaded weight of 90 kg. The missiles are carried on a wheeled or tracked launcher; the tracked launcher weighs 38,000 kg, and the wheeled launcher based upon a Ural 53234 chassis, weighs 25,000 kg. The reload vehicle has the designator 73V6.

Operational status

The SA-I9 missile was first identified as part of the Russian 2S6 Tunguska Air Defence Gun/Missile system in 1986 and it entered operational service in 1988. The system has been exported to Germany, India, Peru and Ukraine. India ordered 60 systems and deliveries started in June 1999. The Pantsir-SI system was first exhibited in 1993, but it is not clear if it has been ordered for use by the Russian armed forces. The UAE is reported to have ordered 50 of the export version, Pantsir-SI TELAR in May 2000, together with an unknown number of missiles with deliveries from 2002 to 2004. These will be fitted to 26 wheeled and 24 tracked TELAR vehicles.

A URAL 53234 truck with the Pantsir-S1 missile and gun system during trials (KBP)
0010183

Specifications

Tunguska (9M311)
Length: 2.63 m
Body diameter: 0.15 and 0.07 m
Launch weight: 42.0 kg
Warhead: 9 kg HE rod
Guidance: Command
Propulsion: Solid propellant
Range: 10 km

Pantsir-SI (9M335/57E6Y)
Length: 3.2 m
Body diameter: 0.17, 0.09 and 0 07 m
Launch weight: 65 kg (9M335) or 74 kg (57E6Y)
Warhead: 16 kg (9M335) or 20 kg (57E6Y) HE rod/fragmentation
Guidance: Command
Propulsion: Solid propellant
Range: 12 km (9M335) or 20 km (57E6Y)

Associated radars
Surveillance/Engagement radar: 'Hot Shot'
Frequency: 4-6 GHz (C-band), 8-12 GHz (X-band), 20-40 GHz (K-Band)
Peak power: n/k
Range: 30 km (C-band), 25 km (X/K-bands)

Contractor

SA-I9 was designed by the KBP Instrument Design Bureau, Tula and manufactured at the Ulyanovsk Mechanical Plant.

S-400(9M96 Trieumf)

Type
Short- and medium-range, ground-based, solid-propellant, theatre defence missiles.

Development
Development is believed to have started in 1990 on a family of missiles to make up a new surface-to-air missile system, called S-400 Trieumf. Two missiles have been developed, the 9M96 with a range of 40 km, and the larger 9M96/2 with a range of 120 km. A third missile is also reported to be in development, with a range of 400 km. The missiles are to defend against aircraft, cruise missiles, UAVs and short-range ballistic missiles. At some stage in the development programme, it was decided to reduce development costs and to use the SA-IO 'Grumble' system as a building block, as an alternative to the Trieumf stand-alone system. The 9M96 and 9M96/2 missiles, in their respective canisters can be fitted to the SA-10D/SA-20 TEL vehicles, with four 9M96 or 9M96/2 missile canisters replacing one SA-10/20 missile canister. This is similar to the US MIM-104 Patriot TEL being fitted with four PAC-3 missiles in place of one Patriot missile. The hybrid SA-I0/20/Trieumf system uses the SA-10D/SA-20-build standard command and control, surveillance and engagement radars, which is the same as the S-300 PMU1 and PMU2 Favorit standard. In 2000 it was reported that the LEMZ 96L6 surveillance radar from SA-20 had been added to the S-400 system. First reports of the Trieumf system were made in 1996, and it was first exhibited and offered for export in 1998. The NATO designator is not known, but the export missiles have the designators 9M96E and 9M96/2E. It is possible that the Trieumf missiles could also be added to the naval version of the SA-IO system, the SA-N-6 'Grumble', provided that the rotary launchers will accept the new missile canisters.

A report in 2001 suggested that a variant of the 9M96 missile had been proposed as a future air-to-air missile. Unconfirmed reports suggest that an improved active radar is being developed for the Trieumf missiles, and that the longer 400 km range version will have a dual-mode semi-active radar/active radar seeker and a new long-range surveillance radar, based on the LEMZ 96L6, with a range of 600 to 700 km.

Description
The 9M96 and 9M96/2 missiles use the same second stage, which has four moving clipped-tip delta control fins located just behind the radome and active radar seeker assembly. The fins fold when the missile is in its canister. The second stage has a solid-propellant sustainer motor, and also has solid-propellant lateral thrust motors located behind the warhead, to provide improved manoeuvrability just before impact with the target. The second stage can manoeuvre at up to 60 g at low altitude. The HE blast/fragmentation warhead weighs 24 kg, and the fragments are directed towards the target by the fuze. Guidance is inertial in mid-course with command updates, with an X-band active radar seeker for the terminal phase. The second stage has a length of 2.0 m, a diameter of 0.24 m, a fin span of 0.4 m and an estimated weight of 140 kg.

The 9M96 missile first stage has four fixed clipped-tip delta wings at the rear, and a solid-propellant boost motor.

Missiles of the S-400 system The SA-20 missile, 48N6/2 (top), 9M96/2 (middle) aiid 9M96 (bottom), with a modified SA-10/20 launcher vehicle behind (Peter Felstead)
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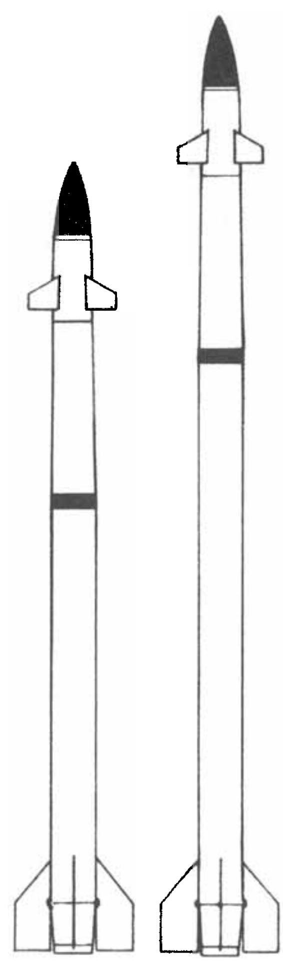
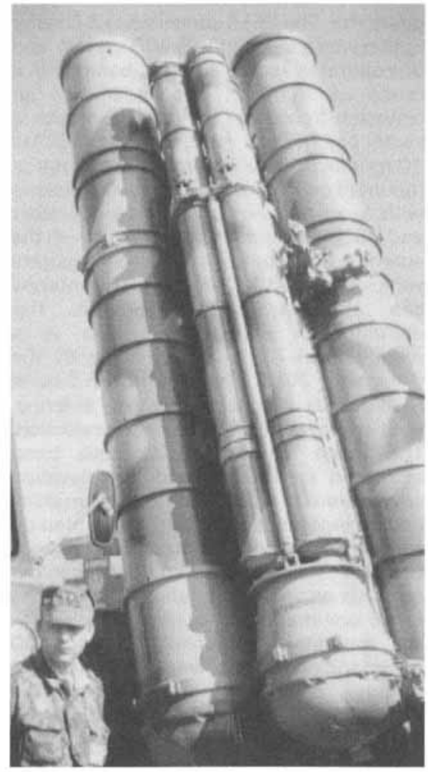


Line diagrams of 9M96 (left) and 9M96/2 (right) missiles ***2001***/0105273

A modified SA-10 TEL, with four 9M96 missile canisters replacing the upper left SA-10 missile canister (Peter Felstead) *2001*/0105271



A modified set of SA-10 canisters, with four 9M96 missile canisters replacing one *SA-10 missile canister* (Peter Felstead) 2001/0105274

This stage is 2.75 m long, has a diameter of 0.24 m, a wing span of 0.48 m, and a weight of 193 kg. The complete missile has a total length of 4.75 m, and at launch, weighs 333 kg. The wings fold in the canister, and the missile is cold launched vertically from its canister to a height of 30 m, when what is described as a gas dynamic system turns the missile towards its allocated target. Four missiles in their canisters weigh 2,300 kg. The 9M96 missile has a minimum range of 1 km, and a maximum range of 40 km against an aircraft target The maximum range will be less against low-flying cruise missiles and UAVs, or against SRBM The maximum missile flight speed is 1.0 km/s. Intercepts can be made against targets flying at between 5 m and 20 km altitude

The 9M96/2 missile first stage has a similar external appearance to that for the 9M96 missile, but the stage is longer and heavier, and contains a larger solid-propellant boost motor. The first stage has a length of 3.65 m, a body diameter of 0.24 m, a wing span of 0.48 m, and a weight of 280 kg. The complete missile has a length of 5.65 m, and at launch, weighs 420 kg. The missile is cold launched from its canister to a height of 30 m, with a gas dynamic system turning the missile towards the allocated target. Four missiles in their canisters weigh 2,700 kg. The 9M96/2 missile has a minimum range of 1 km, and a maximum range of 120 km against an aircraft target. The maximum range will be less against low-flying cruise missiles or UAVs, or against SRBM. The maximum missile flight speed is 0.9 km/s. Intercepts can be made against targets flying at between 5 m and 30 km altitude.

The S-400 system can use a specific to type TEL that carries 12 missiles, or a modified SA-IO 'Grumble' (S-300PMU 1) TEL vehicle. The specific to type TEL is believed to be based upon the SA-IO vehicle design. The modified SA-10 TEL, designated 5P85S, is based on the MAZ 543/7911 chassis and has a weight of 42.1 50 kg. The wheeled TEL has four axles, a four-man crew, and can carry 4, 8, 12 or 16 9M96 or 9M96/2 missiles together with 3, 2, 1, or no SA-IO missiles. The missile canisters are raised to the vertical position before launch, with the TEL vehicle supported on four hydraulic legs. Reload missiles are carried on a SA-10 reload vehicle, designated 5T58, using a crane loader vehicle designated 22T6. The surveillance radar displayed with the system in 1999 was a SA-10 'Tombstone' 3-D radar, designated 64N6, and developed by NIIIP. This 4 to 6 GHz C-band radar has dual-faces with phased-array antenna, using electronic beam steering in both azimuth and elevation, together with mechanical rotation at 6 or 12 rpm. This radar has a maximum range of 250 km against a fighter aircraft target. The radar is mounted on a wheeled vehicle with a total weight of 60,000 kg, there are four operator stations, and the vehicle carries a gas turbine-powered electric

A Flap Lid*B* engagement radar vehicle, exhibited with the *S-400* Trieumf system in *1999* (Peter Felstead) 2001/0105272

generator. The 96L6 surveillance 3-D radar option was added to the S-400 system, and this operates at 1 to 2 GHz (L-band) with a range of 300 km. This radar has an elevation from 0 to 60". and can scan a sector of 120° at 5 rpm or through 360° at 10 rpm for low level search. The antenna is mounted on a MAZ-7930 wheeled chassis with a control shelter for three operators and a SEP-2L electric generator, or with the antenna and control shelter on separate vehicles located 100 m apart. The antenna can also be tower mounted. The multifunction engagement radar is a modified SA-IO 'Flap Lid B', with the designator 30N6. This operates in S-band (2 to 3 GHz) using a phased-array antenna, with improved ECCM and clutter rejection. The range is believed to have been increased to 150 km, and the elevation covers from 0 to 75". The radar can track and engage six targets, and is mounted on a wheeled MAZ-7310 chassis. The SA-20 control system, designated 83M6, can net up to six engagement radars and uses the 54K8 command and control vehicle with six operator positions. The S-400 command and control vehicle can track 40 targets, designate and control the interception of up to eight targets, with one or two missiles fired at each target.

Operational status

It is believed that development of the S-400 Trieumf system started around 1990, flight tests started in 1996, and the development was completed at the end of 2001. Low-rate initial production started in June 2000. Initial evaluation tests started at Kapustin Yar in February 1999, and operational evaluation started in April 2000. It is reported that an initial in-service capability is planned by the end of 2002.

The first units are expected to be located around Moscow. A typical fire unit for the Trieumf system is reported to comprise a command and control vehicle, surveillance radar, engagement radar, three TEL each with 12 missiles, three reload vehicles each with 12 missiles, and a power supply vehicle.

Specifications

9M96

Length: 4.75 m
Body diameter: 0.24 m
Launch weight: 333 kg
Warhead: 24 kg HE blast/fragmentation
Guidance: Inertial, command updates and active radar
Propulsion: Two-stage solid propellant
Range: 40 km

9M96/2

Length: 5.65 m
Body diameter: 0.24 m
Launch weight: 420 kg
Warhead: 24 kg HE blast/fragmentation
Guidance: Inertial, command updates and active radar
Propulsion: Two-stage solid propellant
Range: 120 km

Associated radars
Surveillance radar: 64N6 'Tombstone'
Frequency: 4-6 GHz (C-band)
Average power: n/k
Range: 250 km

Engagement radar: 30N6 'Flap Lid B'
Frequency: 2-3 GHz (S-band)
Average power: n/k
Range: 150 km

Contractors

The major contractors associated with the S-400 system are Almaz NPO, Moscow, Fakel MKB, Khimky (missiles) and NIIIP, Novosibirsk (radar).

SA-N-1 'Goa' (S-125/4K90 Volga-M/Volna/Neva/ Pechora)

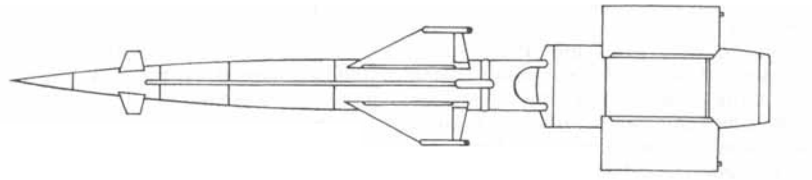
Type

Short-range, ship-based, solid-propellant, theatre defence missile.

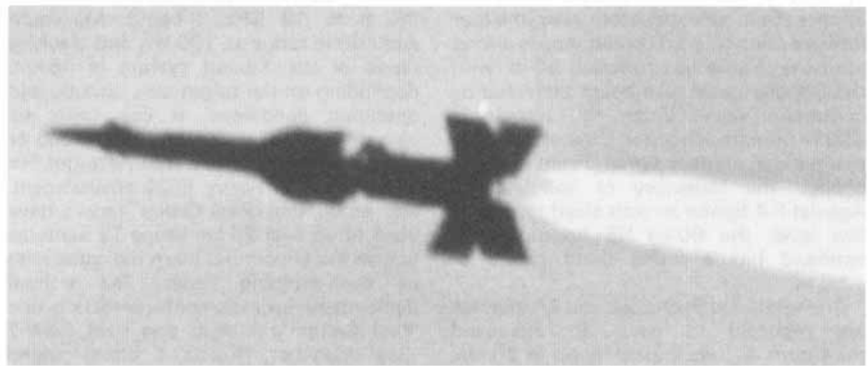
Development

In the late 1950s. the Russian Navy had a standing requirement for an air defence missile for shipboard defence with a secondary anti-patrol boat mission, so it examined the applicabilityof both the SA-2 'Guideline' and SA-3 'Goa' missile systems being developed by the Lavochkin OKB design bureau. The SA-3 'Goa' was selected for the naval variant and was designated M-1 Volga-M or 4K90 Volna by the former Soviet Union and SA-N-1 'Goa' by NATO. The SA-3 'Goa' was probably accepted as the more satisfactory system as its size made it more readily adaptable to smaller warships. Development of the S-125 Neva air defence missile system, designated SA-3 'Goa' by NATO, began around 1956 at the Lavochkin OKB design bureau. Itwas designed to complement the SA-2 'Guideline' at low to medium altitudes and was considered by some to be a counterpart to the US MIM-23 HAWK system. The design of the SA-3's guidance system benefited greatly from earlier work on the SA-2 'Guideline' and the system most closely paralleled the SA-2D 'Guideline' Mod 3, with its associated 'Fan Song E' engagement radar. The propulsion system was novel in one major respect: it was the first Russian air defence missile to use solid-propellant motors in both stages. It would appear that the Russians had several codenames for the programme. 'Neva' appears to refer to the basic S-125 system, while 'Pechora' refers to the S-125 export system. The missile may have also been given its own codename, 'Volga' or 'Volna', and has the designators V-600 (5V24) and V-601 (5V27).

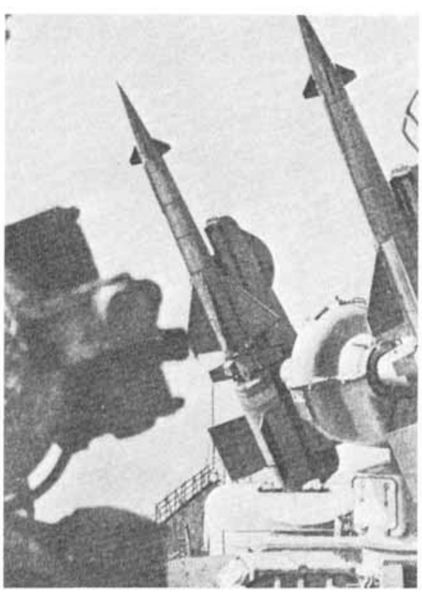
Prototype trials began in 1959, with initial deployment beginning in 1961 at static ground sites. The missile entered operational service later that year, both with the PVO-Strany and the Russian Navy aboard the 'Kotlin' class destroyer *Bravy*. Adaptation of the SA-3 'Goa' system to a naval role was a major undertaking, requiring a complete redesign of the associated launcher and radar equipment. The engagement radar developed for the SA-N-1 was designated 'Peel Group' by NATO. The new system proved practical and became the basis for the air defence missile armament of Russian cruisers and destroyers for nearly a decade, until the advent of the SA-N-3 'Goblet'. The SA-N-1 is fitted to 'Kynda' class (Type 58) cruisers with one twin launcher and 16 missiles, and 'Kashin' class (Type 61) destroyers, with two twin launchers and 32 missiles. The initial version of the missile, the SA-N-1A 'Goa' Mod 0, was the basic model of the system. It was superseded in 1964 by the improved SA-N-1B 'Goa' Mod 1, which had shorter minimum range and improved low-altitude performance. There have been reports of a version of the SA-N-1 'Goa' missile with additional terminal homing, but this has not been confirmed. In 1998, a Pechora 2 missile was offered for export, with automatic passive target and acquisition using TV and imaging IR sensors. The missiles were upgraded with digital electronics, new motors and warheads, new fuzes and improved ECCM. Flight tests started in 1999. A further upgrade, Pechora 2A, was proposed for export in 2000, with 44 analogue units replaced with 6 digital units. The digital units were adapted from the S-300 (SA-10/20 'Grumble') system to improve tracking, upgrade the ECCM and introduce BITE.



A line diagram of the SA-N-1 'Goa' missile 0010168



Russian SA-N-1 'Goa' missile in flight before booster is jettisoned



Two SA-Al-1 'Goa' missiles mounted on the twin launcher assembly

Description

The SA-N-1 'Goa' uses the same missile as the SA-3 'Goa' system. It is a two-stage missile with a large, solid-propellant, tandem jettisonable booster fitted with four large rectangular stabilising fins. One of the unusual features of the design is the configuration of these booster fins. Prior to launch, the fins are folded forward with the leading-edge against the booster casing. At launch, they pivot back 90°, thus increasing the span. The missile body is cylindrical in shape with four clipped delta-shaped wings, each with antennas (command and beacon) on the tips aft of mid-point. Four small clipped delta moving control fins are located forward on the nose taper and there are four rectangular fins at the tail.

The overall length of the missile is 6.1 m, the diameter of the booster stage is 0.55 m and that of the missile is 0.37 m. The weight of the SA-N-1A at launch is 946 kg, whereas the 1B is slightly heavier at 950 kg. Both versions have the same 60 kg HE fragmentation warhead with Doppler radar proximity and contact fuses. USA reports suggest that a nuclear warhead version was developed for SA-N-1, but this remains unconfirmed. The twin missile launcher is fully automated and stabilised with an associated magazine. The original system mounted on the *Bravy* was described in Western reports as having a capacity of 20 missiles. Although a standardised two-rail launcher was developed for the SA-N-1 'Goa', it is unclear whether a single-magazine design was adopted, as various reports describe the missile magazines as containing 16, 20, 22, 24 and 32 missiles. When the missile is launched, the solid-propellant booster burns for 2.6 seconds and is then jettisoned. The 19-second burn solid-propellant sustainer motor then takes over, accelerating the missile to M3.5. The SA-N-1A had a maximum range of 30 km, while the improved low-level performance of the SA-N-1B versions resulted in a shorter maximum range of 25 km. The minimum range of the SA-N-1A was 6 km

and this was reduced to 3.5 km for the SA-N-1B version. The SA-N-1A had a maximum altitude for interception of 12 km, while the SA-N-1B has a minimum interception altitude of 10 m and a maximum of 18 km. During the missile's flight, the fire-control computer continues to receive data from the 'Peel Group' engagement radar, which is now tracking both target and missile. The computer continually generates commands to guide the missile to the target and these are transmitted via a B-band UHF radio beam datalink, to the wingtip antennas. The onboard guidance unit accepts these and adjusts the missile trajectory using the four forward control fins. The warhead is armed after the missile has travelled 50 m, with the Doppler radar fuse being activated by command signal when the missile is 300 m from the launcher. If the missile fails to intercept, another signal is sent to either change the trajectory or self-destruct. Against F-4 fighter aircraft sized targets at low level, the 60 kg HE fragmentation warhead has a lethal burst radius of 12.5 m.

The upgraded Pechora 2 and 2A missiles are reported to have an increased maximum altitude capability up to 20 km, and to have a range of up to 20 km against low-level targets. The maximum range against medium level (10 km) targets is 28 km.

The 'Peel Group' engagement radar bears little resemblance to its land-based counterpart the 'Low Blow', presumably due to the stringent stabilisation requirements for shipboard use. Within the group there are X-band tracking, target illumination and missile guidance radars. All four scanners are of solid reflector construction and of elliptical parabaloid shape. There are two large and two small scanners in each group, one of each size being positioned with its major axis horizontal and the other vertical. The central mounting has noticeably rounded proportions and appears to provide a common axis about which the group rotates in azimuth. The large forward side of this mounting is another large housing providing for rotation of the group in elevation. The large vertical antenna is for target illumination, while the large horizontal one serves for missile guidance. The two small vertical and horizontal antennas serve as counterparts to the trough antennas on the 'Low Blow'. The large feed boxes of the two smaller scanners suggest that a monopulse tracking technique is used, with separate radars for each co-ordinate, azimuth and elevation. Operating frequency of the two smaller radars in the group is probably in the 8 to 10 GHz (X-band). Maximum acquisition range is 100 km and tracking range of the X-band system is 45 km, depending on the target size, altitude and operating conditions. It can track six aircraft simultaneously and guide one or two missiles at once to the same target. For operating in a heavy ECM environment, late production 'Peel Group' radars have been fitted with 25 km range TV cameras to give the fire-control team the same data as the emitting radar. The normal deployment arrangements associate one 'Peel Group' unit with one dual SA-N-1 'Goa' launcher. 'Kresta I' class guided missile cruisers have two installations, one forward above the bridge and the other aft, atop a short tower; 'Kashin' class Guided Missile Destroyers (GMDs) are similarly fitted. The 'Kynda' class GMDs have a 'Peel Group' installation above the bridge and on 'Kotlin' class GMDs there is a 'Peel Group' on a square, tapered tower amidships.

Operational status

The initial model SA-N-IA 'Goa' Mod 0 entered service in 1961. This was followed in 1964 by the improved version SA-N-1B 'Goa' Mod 1. A total of 45 Russian destroyers and cruisers were fitted with the SA-N-1 'Goa' missile system including the 'Kresta I' and 'Kynda' cruisers and the 'Kanin', 'Kashin' and 'Kotlin' destroyers. A single 'Kotlin' destroyer with SA-N-1 missiles was transferred to Poland and three new construction 'Kashin II' destroyers with SA-N-1 were completed for India in 1980 and 1982. By 1998 the number of Russian ships still carrying SA-N-1 missiles had reduced to one 'Kynda' (Type 58) cruiser, one modified 'Kashin' destroyer and one 'Kashin' (Type 61) destroyer. The land-based version SA-3 'Goa' is believed to have continued in production until the mid-1980s and has been widely exported, but the only known exports of SA-N-1 are to India, Poland and Ukraine.

Specifications

SA-N-1A
Length: 6.1 m
Body diameter: 0.37 m (booster 0.55 m)
Launch weight: 946 kg
Warhead: 60 kg HE fragmentation
Guidance: Command
Propulsion: Solid propellant
Max range: 30 km

SA-N-1B
Length: 6.1 m
Body diameter: 0.37 m (booster 0.55 m)
Launch weight: 950 kg
Warhead: 60 kg HE fragmentation
Guidance: Command
Propulsion: Solid propellant
Max range: 25 km (1B), 28 km (Pechora 2)

Associated radars
Surveillance/Engagement radar: 'Peel Group'
Frequency: 8.9-9.46 GHz (X-band)
Peak power: n/k
Range: 100 km acquisition, 45 km engagement
Missile command link: 250-500 MHz

Contractor

SA-N-1 'Goa' was designed by the Lavochkin OKB, with assistance from the Grushin OKB. SA-N-1 is being supported by Altair NPO, Moscow and Fakel MKB, Khimky.

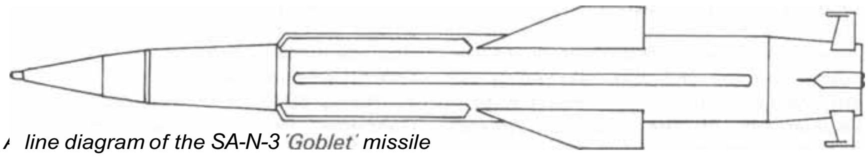
SA-N-3 'Goblet' (4K60 and 4K65 Shtorm)

Type

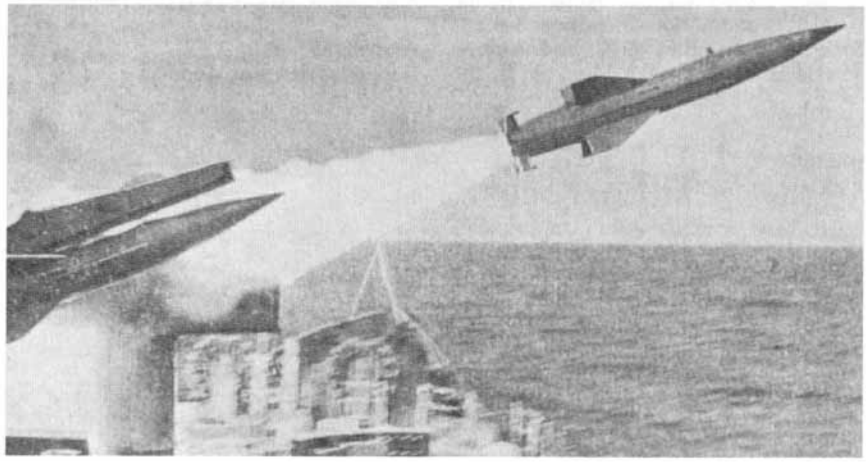
Short-range, ship-based, solid-propellant, theatre defence missile.

Development

The SA-N-3 'Goblet' is the only Russian air defence missile developed exclusively for naval use. It is believed to have had the Russian system designators 4K60 and 4K65, with the system known as Shtorm. Development of the SA-N-3 began in the early 1960s as a successor to the SA-N-I 'Goa', naval derivative of the SA-3 'Goa'. The system was probably designed as a dual-role missile, intended both for air defence and anti-ship missions. The SA-N-3 missile was intended to arm large ships and the first ship fitted with the 'Goblet' system was the aviation cruiser *Moskva,* which entered construction in 1962 and was finally commissioned in 1967. The basic system fitted to early ships was the SA-N-3A 'Goblet' Mod 0, believed to have the Russian designator 4K60. An improved version employing a larger magazine and using an improved SA-N-3B 'Goblet' Mod 1 missile, with the Russian designator 4K65, was fitted to the 'Kiev' class aircraft carriers and 'Kara' class (type 1134.B) cruisers. The 'Kara' cruisers have one or two twin launchers and carry 40 or 80 missiles. The improved system had a greater range as well as internal improvements to the missile. The later ships also had an updated version of the 'Head Lights' engagement radar.



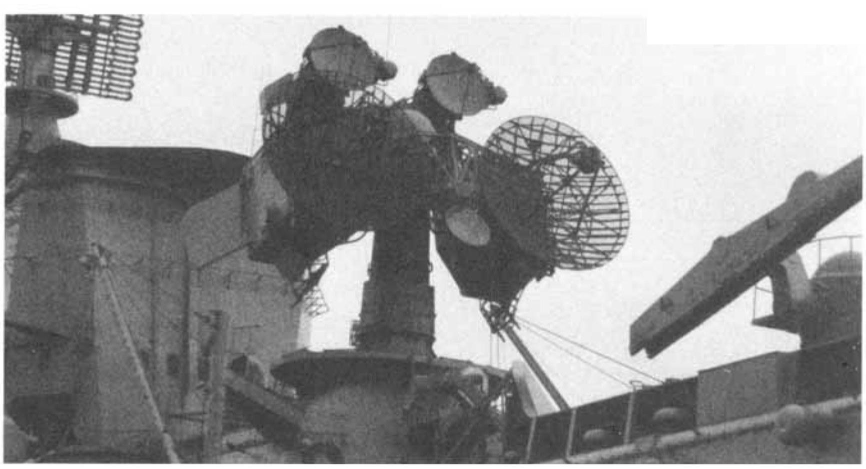
A line diagram of the SA-N-3 'Goblet' missile



An SA-N-3 'Goblet'surface-to-air missile being launched from a twin launcher assembly

Description

The SA-N-3 'Goblet' is cylindrical in shape, and has a long pointed double-taper nose. Just aft of the mid-body point it has four fixed clipped and raked delta-wings and there are four rectangular fins at the tail, with control surfaces on their trailing-edges as well as semi-active radar antennas on the tips. There are two stub fins between the tailfins, with tip-mounted beacon transponder and datalink receiver antennas. The missile also has four prominent strip antennas just forward of the wings, which are thought to be used for a radar proximity fuse. The 'Goblet' missile is 6.1 m long, has a body diameter of 0.6 m and, with an 80 kg HE fragmentation warhead, weighs 845 kg at launch. US reports suggest that a nuclear warhead was developed for SA-N-3, but this remains unconfirmed. It is believed that the SA-N-3 uses a dual-thrust solid-propellant motor, which would represent the earliest example of this type of propulsion system in a Russian SAM. Guidance during mid-course is by a UHF radio-command datalink and the terminal phase is by semi-active CW radar homing. The engagement radar for the system is designated 'Head Lights' by NATO and operates in the 4 to 8 GHz (C-band). This is aided by the ship's prime sensor, usually the 'Top Sail' three-dimensional L-band radar. The launcher system consists of a twin launch rail stabilised unit, each launch rail having its own reloading system and magazine. A typical target engagement is believed to take place as follows: the target is first detected at long range by the ship's early warning radar system which then passes the data to the fire-control centre, where the 'Head Lights' continuous wave engagement and command-guidance radar takes over. Additional height information is provided by the ship's 'Top Sail' radar. Once in range, a single missile is launched and guided to the target by the guidance beam with a semi-active terminal homing phase. The SA-N-3A Mod 0 missile has range limits of 3 to 30 km and an altitude engagement envelope of between 100 m and 25 km. The 3B Mod 1 has a greater maximum range of 55 km but has the same altitude envelope.



A 'Head Lights' radar group behind an SA-N-3 launcher

The 'Head Lights' engagement radar antenna array is symmetrical with a pair of large, 4 m open mesh circular parabolic dishes below and a pair of smaller parabolic dishes, of about 1.8 m diameter, above. There is also a small dish antenna centrally mounted. The whole assembly rotates in azimuth and can also move in elevation. The two upper radars also appear to have provision for individual movement in both axes, possibly limited, with dynamic balancing vanes fitted to them. The maximum range of the 'Head Lights' system is 60 km and the elevation envelope is between 100 m and 25 km. There are three versions of the 'Head Lights' system, 'Head Lights A, B and C', all of which operate in the 4 to 8 GHz frequency band. There were two groups of 'Head Lights A' fitted forward on the 'Moskva' class aviation cruiser and to the early 'Kiev' class aircraft carriers. Two groups of 'Head Lights B' are fitted fore and aft on the 'Kara' and 'Kresta II' class cruisers. 'Head Lights C' was used on the final two 'Kiev' class aircraft carriers, the *Novorossiysk* and *Baku.* 'Head Lights C' is also used with the SS-N-14 'Silex' surface-to-surface missile. The small upper antennas are probably used for command guidance, while the lower antenna provides tracking. The small single antenna may be used to receive downlink signals from the missile. The system seems to be

configured for engaging a single target simultaneously using two missiles.

Operational status

The SA-N-3A 'Goblet' Mod 0 system entered service in 1967, on board the cruiser ***Moskva.*** This was followed by the improved version SA-N-3B 'Goblet' Mod 1. Deployment of the 'Goblet' systems peaked in the mid-1970s. but by 1998 they were only fitted to two 'Kara' class cruisers. SA-N-3 has been replaced by the SA-N-6 'Grumble', which commenced sea trials in December 1977 and entered service in 1980. SA-N-3 was used by the Ukraine on 'Kara' class ships, but these have now been scrapped.

Specifications

Length: 6.1 m
Body diameter: 0.6 m
Launch weight: 845 kg
Warhead: 80 kg HE fragmentation
Guidance: Command with semi-active homing
Propulsion: Solid propellant
Max range: 30 km, Mod 0; 55 km, Mod 1

Associated radars
Surveillance radar: 'Top Sail'
Frequency: 1-2 GHz (L-band)
Peak power: n/k
Range: 550 km

Engagement radar: 'Head Lights'
Frequency: 4-8 GHz (C-band)
Peak power: n/k
Range: 60 km

Contractor

Not known, but believed to be Lavochkin or Grushin OKBs. It is believed that these two OKBs were absorbed into the Fakel MKB and SA-N-3 is now supported by Fakel MKB, Khimky.

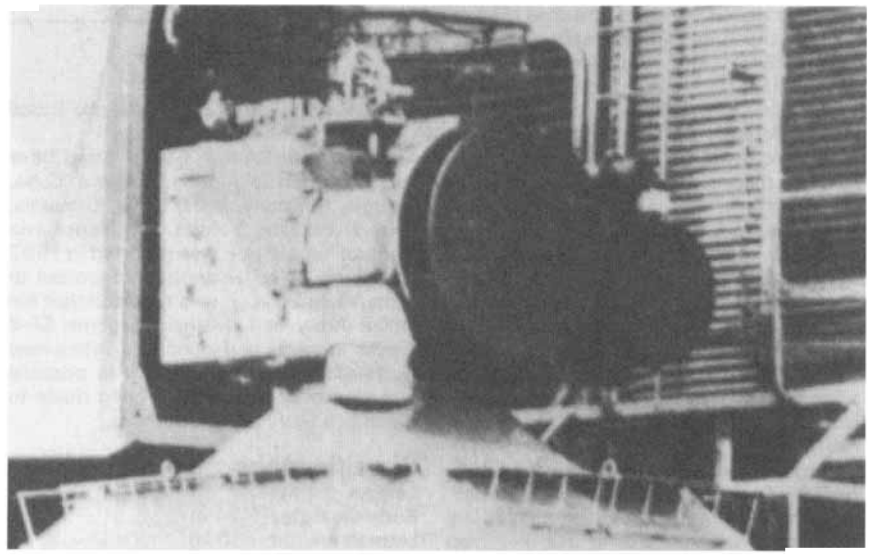
SA-N-4 'Gecko' (9M33 Osa-M/R3-13)

Type

Short-range, ship-based, solid-propellant, theatre defence missile.

Development

In the mid-I960s. the Russian Navysought an effective low-altitude air defence system for small surface ships, as the existing low- to medium-altitude system, the SA-N-1 'Goa', was too large for smaller ships. The SA-6 'Gainful' was delayed and in any case was too large for the Navy. Development of the SA-N-4 'Gecko' naval system began around 1965, with the Russian designator 4K33, but the missile itself was designated Osa-M and given the number 9M33 or R3-13. It is unclear which ship served as the testbed for the system, but it is known that the first ship laid down with provisions for this system was the lead ship of the 'Grisha I' class of frigates, launched in 1967. The new missile system was designated SA-N-4 'Gecko' by NATO. Some Russian naval air defence missiles have a secondary anti-ship role and Russian ships have been observed firing the SA-N-4 at target barges. The Russian Army version, the ZRK Romb, was first noted by Western intelligence in 1973 and the initial production type, designated SA-8A 'Gecko' Mod 0, was first publicly displayed in November 1975. An improved type, designated SA-86 'Gecko' Mod 1, was seen in Germany in 1980 and it is safe to assume that these or similar improvements were carried over into the SA-N-4 'Gecko' system. There have been reports of further versions of the missile with infra-red or semi-active radar terminal homing seekers, but this has never been confirmed. An increased range version of the land-based SA-8 was tested in India in April 2001.



A 'Pop Group' antenna array, with the rotating surveillance radar antenna on the top, the engagement radar antenna (the larger circular radome) and the missile tracker (the smaller circular radome)

Description

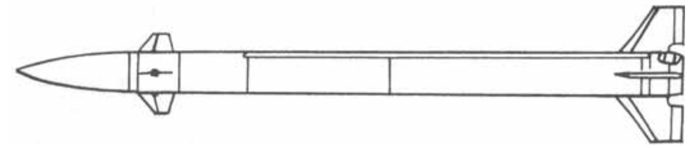
The SA-N-4 'Gecko' has a slender cylindrical body with four small clipped delta control fins situated forward on the nose and four fixed in-line clipped delta tailfins. The missile is 3.1 m long, has a body diameter of 0.21 m and, with an 18 kg HE fragmentation warhead, weighs 130 kg at launch. The missile is fitted with two beacon transponders mounted on the rear fuselage. There appears to be no physical difference between the Mod 0 and Mod 1 missiles, but the limited information available suggests internal improvements to the guidance and increased speed and range. The radar system associated with the SA-N-4 'Gecko' is called the 'Pop Group' by NATO. It is similar to the land-based version 'Land Roll', but only has a single missile guidance package. This system is reported to be of the frequency-agile monopulse type. It consists of an elliptical rotating surveillance radar antenna operating in the C-band (6 to 8 GHz), which has a 30 km acquisition range against most targets. There is also a pulse X-band (8 to 12 GHz) engagement radar antenna with a maximum tracking range of about 20 km, mounted on the side of which is a small X-band parabolic dish antenna to track the missile. Above this is a small circular antenna which emits an X-band uplink capture beam to gather the missile shortly after launch. The final antenna in the array is a small white, rectangular command uplink emitter. On the land version there is a tubular device fitted to the tracking radar. This device is thought to be an EO/LLTV optical adjunct tracker, which would be used to track the target when the main tracking radar is jammed by ECM. It is not known whether the same device is fitted to SA-N-4. The twin missile launcher is stowed in a below-decks bin, which is part of the loading magazine and this whole launcher assembly is raised to deck level whenever firing is required. After firing, the launcher is lowered again into the bin for reloading, with the missiles in the magazine stored nose down in four vertical rings, with five missiles in each ring. When the missile is launched, the booster motor burns for 2 seconds, permitting the radar to gather and control it at very short ranges (about 1.6 km). The sustainer motor has a 15 second burn, bringing the missile to a top speed of about M2.0. Once launched, the missile is command-guided for the whole flight and the warhead is detonated by its proximity fuse or possible command. The warhead is said to have a lethal radius of 5 m at low altitude against a fighter aircraft size target. The SA-N4A Mod 0 missile has range limits of 1.5 to 10 km and an altitude engagement envelope of between 10 m and 5 km. The SA-N-46 Mod 1 has a greater maximum range of 15 km, but has the same altitude envelope.

Two SA-N-4 'Gecko' missiles mounted on a twin launcher assembly (Harry Steele) 0010184

Operational status

SA-N-4 Gecko entered service in 1968 fitted to two frigates of the 'Grisha I class It has since been fitted to Krivak I' Krivak II 'Krivak III', 'Gepard' and 'Grisha III' frigates;

'Nanuchka' and 'Sarancha' corvettes; and the 'Dergach' class fast attack craft air cushion vessels. It has also been fitted to a number of larger ships to supplement longer-range air defence missiles. These included the 'Kiev' aircraft carriers, 'Kirov', 'Slava', 'Kara' and modified 'Sverdlov' cruisers. It is also found onboard the 'Ivan Rogov' class of amphibious landing ships, and the ***Berezina*** support ship. These ships have one or two twin launchers, with either 20 or 40 missiles. The first mobile Russian Army version was seen in 1974 and designated SA-8 'Gecko'. In 1980 an updated missile was introduced into the army system and was designated SA-8B 'Gecko' Mod 1. It is assumed that this missile was also incorporated into the SA-N-4. The SA-N-4 'Gecko' was the most widely used Russian Naval command-guided SAM, with a total of over 123 Russian warships fitted with it by 1987. In 1989 it was reported that the SA-N-4 system was being augmented by the CIWS SA-N-11 on some larger ships. The SA-N-9 'Gauntlet' system is replacing SA-N-4 in more modern ships, but in 1995 it was believed that over 100 ships still carried the SA-N-4 'Gecko' system. Over 55 warships with SA-N-4 'Gecko' fitted have been exported to Algeria, Bulgaria, Cuba, Georgia, Germany, India, Libya, Lithuania, Poland, Ukraine, Yemen and Yugoslavia (Federal Republic). It was reported in 1997 that some SA-N-4 have been exported to Armenia. In 2000, it was reported that the Indian Army had overhauled some SA-8 'Gecko' missiles and launchers, fitting new warheads and motors, and it is possible that similar upgrades have been made to the Indian Navy SA-N-4 missiles.



A line diagram of the SA-N-4 'Gecko' missile

Specifications

Length: 3.1 m
Body diameter: 0.21 m
Launch weight: 130 kg
Warhead: 18 kg HE fragmentation
Guidance: Command
Propulsion: Solid propellant
Range: 10 km (Mod 0); 15 km (Mod 1)

Associated radars
Surveillance/Engagement radar: 'Pop Group' (4R33)
Frequency: 6-8 GHz (C-band) surveillance, 8-12 GHz (X-band) engagement
Peak power: n/k
Range: 30 km surveillance, 20 km engagement

Contractor

SA-N-4 'Gecko' was designed by the Grushin OKB. but is now marketed by Antey NPO, Moscow and supported by the Fakel MKB, Khimky.

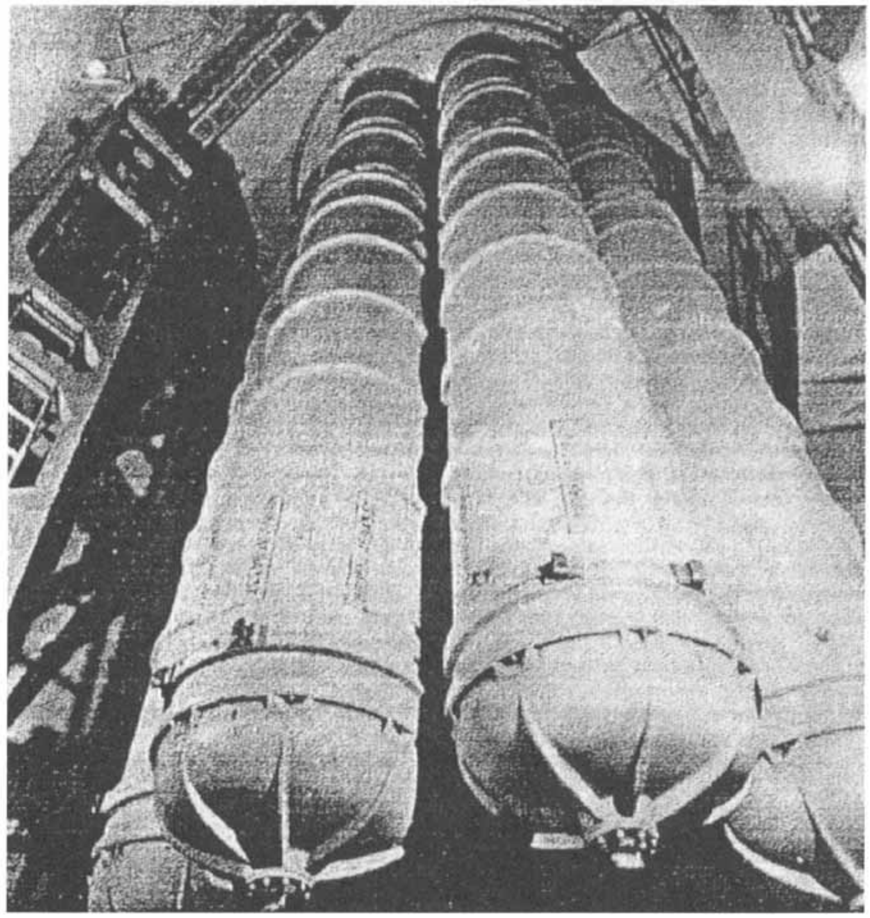
SA-N-6 'Grumble' (S-300 Fort/Rif)

Type
Short-range, ship-based, solid-propellant, theatre defence missile.

Development
Designed in the late 1960s and jointly developed in the early 1970s. the SA-N-6 'Grumble' and SA-10/20 'Grumble' programmes were managed by the Grushin and Raspletin missile design bureaus and have the Russian designator S-300. The Russian name for the SA-N-6 system is Fort or Rif. It is thought that the original requirement was to provide a high-altitude surface-to-air missile, also capable of defending against the larger air-to-surface missiles. This requirement was almost certainly modified in the early 1970s. during a protracted development and evaluation phase, to include an improved capability against low-flying aircraft. The SA-10/20 'Grumble' missile system has been tested against ASM and SSM, and has a limited capability against short-range ballistic missiles. SA-N-6 represents the first ship-based SAM system with a possible capability against short-range ballistic missiles. There are several build standards of the missile, designated 5V55K, 5V55R, 5V559, 48N6 and 48N6/2 by the Russians, with ranges of 45, 75, 90, 150 and 200 km respectively. It is not known whether the ship-based missiles have been upgraded, or to which standard. SA-N-6 'Grumble' was first deployed at sea in 1977 on board the Russian trials missile cruiser *Azov,* which has four vertical launcher assemblies, each housing an eight-missile rotary launcher. Operational fits have been seen on the 'Kirov' (Orlan, type 1144) class cruisers, with 12 vertical launch hatches and 96 missiles. 'Slava' (Atlant type 1164) class cruisers have eight vertical launch hatches and 64 missiles. 'Kara' (Berkot-B type 11348) class cruisers, with six vertical-launch hatches and 24 missiles.

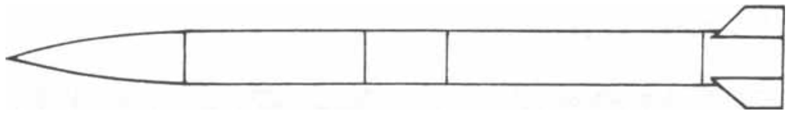
There are unconfirmed reports that an active radar seeker has been developed for the 'Grumble' missile. In 1998 the land-based SA-20 (S-300 PMU-2 Favorit) version was being offered for export with two new missiles, a 9M96 missile with a range of 40 km and a 9M96/2 missile with a range of 120 km. These two new missiles are smaller than the SA-N-6 'Grumble' missile and have smaller canisters that might or might not fit the existing ship launchers. The S-400 land-based SAM system uses SA-20, 9M96 and 9M96/2 missiles together in the same system, with upgraded radars. For further details see separate entry.

Description
The SA-N-6 'Grumble' missile (5V559 version) is 7.25 m long, has a body diameter **of** 0.45 m and a launch weight of 1,625 kg. The missile has four clipped folding and moving control fins at the rear. Guidance in mid-course is inertial with updates from the engagement radar: in the terminal phase a track-via-missile semi-active radar is used, similar to that used in the US Patriot SAM system. The single solid-propellant motor gives the 5V559 missile a high-level range of 90 km, but this would be reduced to 25 km against low-flying targets. The minimum range is 7 km. It is believed that the earlier Fort system installed in the 'Kirov' cruisers used 45 km range missiles with six-cell rotary launchers, while the later Rif system on the



A view of the rotary launcher for SA-N-6 'Grumble'

The foredeck of Admiral Nakhimov *showing the 72 SA-N-6 Grunible launch hatches forward of the 20* ***SS-N-19*** *'Shipwreck missile hatches*



***A** diagram of the SA-M-6 'Grumble'surface-to-air missile* **0010185**

'Slava' cruisers used eight-cell rotary launchers and the 90 km range improved missiles. The missile has a peak velocity of 2 km/s and a capability against targets as low as 10 m and up to 27 km (88,000 ft). SA-N-6 missiles have a 133 kg warhead with a RF proximity fuse. It has been reported that 'Grumble' missiles have alternate conventional HE fragmentation and nuclear warheads. The missiles are transported in 500 kg canisters, which are sealed and maintenance-free for 10 years. The missiles are cold-launched from the vertical launcher, with a time delay of 3 seconds between launches. It seems doubtful that 'Grumble' could intercept low radar cross-section cruise missiles flying at a few metres above the sea and it is believed that the smaller SA-N-9 system was added to counter this later threat. It is possible that the new 9M96 and 9M96/2 missiles have been designed to obviate the need to add SA-N-9 systems on future ships.

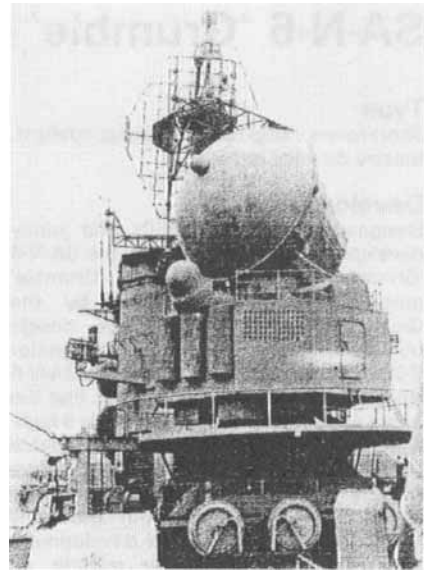
The SA-N-6 'Grumble' system requires a long-range three-dimension surveillance/ tracking radar to make the initial contact on airborne targets and initiate tracking. Radars so far used for this purpose include 'Top Pair' 500 MHz to 2 GHz (L-band) (Russian designation MR600 Voskhod) and 'Top Steer' 1 to 3 GHz (S-band) (Russian designation MR700 Fregat). Missile guidance is provided by 'Top Dome' (Russian designation 3R41 Volna), a large 10 GHz (X-band) engagement radar of distinctive configuration. The 'Top Dome' radar appears to be a complex system incorporating a number of different antenna elements, clearly denoting multipurpose operation using a phased-array antenna system. The largest of these elements is concealed behind the 4 m hemispherical radome, which is similar in appearance to a very large 'bucket' on its side. This antenna can be mechanically steered in azimuth but is fixed at an angle of 20" in elevation. The purpose of this element of the 'Top Dome' group is to track both targets and outgoing missiles, probably on a time-share basis. Carried on the side of the same trainable pedestal and in-line with the main radar antenna, is a group of three rectangular semi-cylindrical antennas, the precise function of which is not clear. Above and in the middle of these, is a small 'drum'-shaped unit, mounted in-line and at the same elevation angle as the main antenna. It is thought that this might house the command datalink antenna. There are reports that the 'Top Dome' radar can handle up to six simultaneous missile engagements, with two missiles being guided to each target.

Operational status

SA-N-6 'Grumble' entered service in 1982 and there may be several modification standards now in service with the Russian and Ukraine navies. The system was offered for export in 1992. China has bought the SA-10 'Grumble' land-based system and may be planning to purchase SA-N-6 later. From 1996, an upgraded version, with the Russian name Fort-M, has also been offered for export with the 48N6 missile. This version may have been retrofitted to some of the Russian ships with the system. The latest version of the missile, the 48N6/2, was first flight tested in 1995 and is reported to have made several successful interceptions against short-range ballistic missiles. The land-based version, SA-20, is believed to have entered service in 2000, and a similar version might be fitted to ships. Two new and smaller missiles, designated 9M96 and 9M96/2 have been developed, and were flight tested from a land-based SA-20 launcher in early 1999. It is not known if these will be fitted to ships.

Specifications

Length: 7.25 m
Body diameter: 0.45 m
Launch weight: 1,625 kg
Warhead: 133 kg HE or nuclear
Guidance: Inertial with updates and semi-active radar TVM



*The **'Top** Dome engagement radar associated with the SA-N-6 Grumble' SAM system*

Propulsion: Solid propellant
Range: 90 km

Associated radars
Surveillance radars: 'Top Steer' (MR700 Fregat)
Frequency: 1-3 GHz (S-band)
Peak power: n/k
Range: n/k

'Top Pair' (MR600 Voskhod)
Frequency: 500 MHz-2 GHz (L-band)
Peak power: n/k
Range: 200 km

Engagement radar: 'Top Dome' (3R41 Volna)
Frequency: 10 GHz (X-band)
Peak power: n/k
Range: 100 km

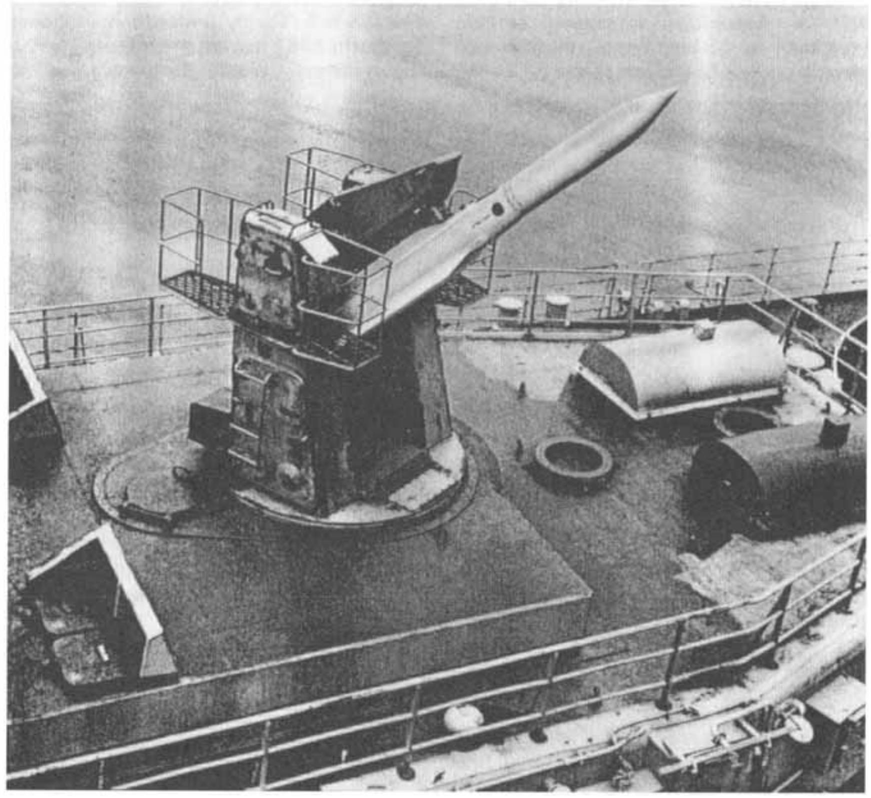
Contractor

SA-N-6 'Grumble' was designed by the Grushin and Raspletin OKBs and it is believed that these have been combined within the Fakel MKB, Khimky. The ship-based version is now marketed by Altair NPO, Moscow

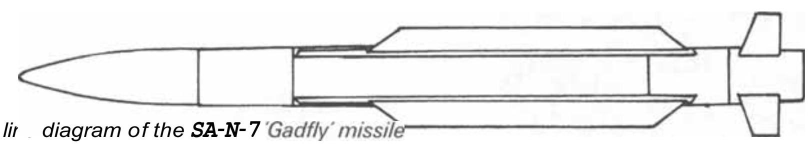
SA-N-7 'Gadfly' (9M38 Urugan/Shtil)

Type
Short-range, ship-based, solid-propellant, theatre defence missile.

Development
The SA-N-7 'Gadfly' missile system programme followed a pattern established by earlier Russian air defence missile programmes, like the SA-N-4/SA-8 'Gecko', with both the army and navy jointly funding a common missile and related system, then with each of the services developing their own specialist support equipment. The SA-N-7's counterpart in the Russian Army is the SA-I 1 'Gadfly'. The Russian name for the SA-N-7 is Urugan (3K90) for the navy system and Shtil for the export system; the missiles have the designator 9M38. Development of the joint programme is believed to have begun in the early 1970s. as a Russian Army requirement for a follow-on to the SA-6 'Gainful' which had entered service between 1967 and 1970. The SA-N-7 'Gadfly' was intended for use on the larger destroyers in lieu of the outdated SA-N-1 'Goa'. The new X-band engagement radar was designated 'Front Dome' for the SA-N-7 and 'Fire Dome' for SA-I 1. However, the programme suffered many delays during the development of the 'Gadfly' missile, so many that the army introduced an interim system designated SA-6B 'Gainful' Mod 1 until the missile development was complete. This entailed using the latest mark of SA-6 missile with the new SA-I1 launch vehicle and associated radar and was introduced into service around 1977. The problems encountered with the 'Gadfly' missile were eventually solved and the definitive SA-I 1 'Gadfly' system entered service in 1979. The SA-N-7 'Gadfly' system was first fitted on the 'Kashin' class trials destroyer *Provorny* in the late 1970s. prior to its adoption and entry into service on the 'Sovremenny' class of destroyers. The *Provorny* was converted at the 61 Kommuna Shipyard in Nikolayev in the late 1970s and went back to sea in 1981. The SA-N-7 'Gadfly' system was mounted on the rear platform in place of the earlier SA-N-1 'Goa' missile system. Provisions were made for two more mountings towards the bow, but these were never fitted. The new 'Top Steer' surveillance radar was added, along with eight 'Front Dome' engagement radar antennas for the SA-N-7 system. The first 'Sovremenny' (Sarych type 956) was commissioned in 1985 with two SA-N-7 'Gadfly' launchers and 48 missiles. A modified version of SA-I 1 was developed, to enable the missile to be targeted against surface targets and a similar modification was made to the SA-N-7 system, with the designator 9K90M-22. Development work started on the SA-I 1 replacement, which has been designated SA-I7 'Grizzly' by NATO, in 1987 and this system entered initial production in 1992. It is reported that a naval version of SA-I7 began to replace SA-N-7 'Gadfly' on the later Sovremenny ships from 1993 and it is believed that this has the NATO designator SA-N-12. The Russian designator Buk-



An SA-N-7 'Gadfly' missile and launcher assembly



A lir diagram of the SA-N-7 'Gadfly' missile

MI-2 has been given to a hybrid system, which uses the improved SA-I7 'Grizzly' missile with the SA-I 1 or SA-N-7 'Gadfly' system.

Description
The SA-N-7 'Gadfly' missile is similar in appearance to the US Navy's Standard MR RIM-66 air defence missile. The missile has four long-chord, short-span wings aft of mid-body and four in-line clipped delta moving control fins on the boat-tail. It has an overall length of 5.55 m, a body diameter of 0.4 m and weighs 690 kg at launch. The 70 kg HE fragmentation warhead is initiated by an RF fuse or contact fuse. US reports that a nuclear warhead version was developed have not been confirmed. Propulsion is by a solid-propellant motor, which gives the missile a M3.0 velocity and a maximum slant range of 35 km against aircraft targets, which reduces to 12 km against missile targets (ASM or SSM). The 'Gadfly' is reported to have a similar flight profile to the US Standard missile, climbing up and then diving down onto the target. The missile's minimum range is 3.5 km and the intercept altitude envelope is between 15 m and 22 km. SA-N-7 has a mid-course guidance system that is inertial with command updates, followed by a semi-active monopulse Agat 9E50M radar in the terminal phase, which relies on continuous wave illumination of the target by the 'Front Dome' (MR-90 Orekh) engagement radar. 'Front Dome' operates in the 6 to 10 GHz band (X-band), has an elevation coverage from 0 to 70° and a range of 30 km. The engagement radar is supported by an EO tracker and laser range-finder for use in ECM conditions and it is reported that the missile can be command-guided using the EO tracker. SA-N-7 is supported by the 'Top Steer' 1 to 3 GHz (S-band) three-dimensional early warning and surveillance radar (MR750 Fregat), which has a range of 300 km. On the latest destroyer, this has been replaced by an improved 'Top Steer/Top Plate' surveillance radar. The missile launcher is a 3S90 single rail type, similar in appearance to the US Navy Mk 13 launcher. The 'Sovremenny' class destroyer is fitted with two launchers, one fore and one aft, each with a 24-missile magazine below decks. There are six 'Front Dome' engagement radars and each launcher has a 12-second reload time to permit several missiles to be launched in quick succession. Simultaneous engagements can be carried out with up to three missiles being guided to an individual target. The number of targets engaged is limited by the number of

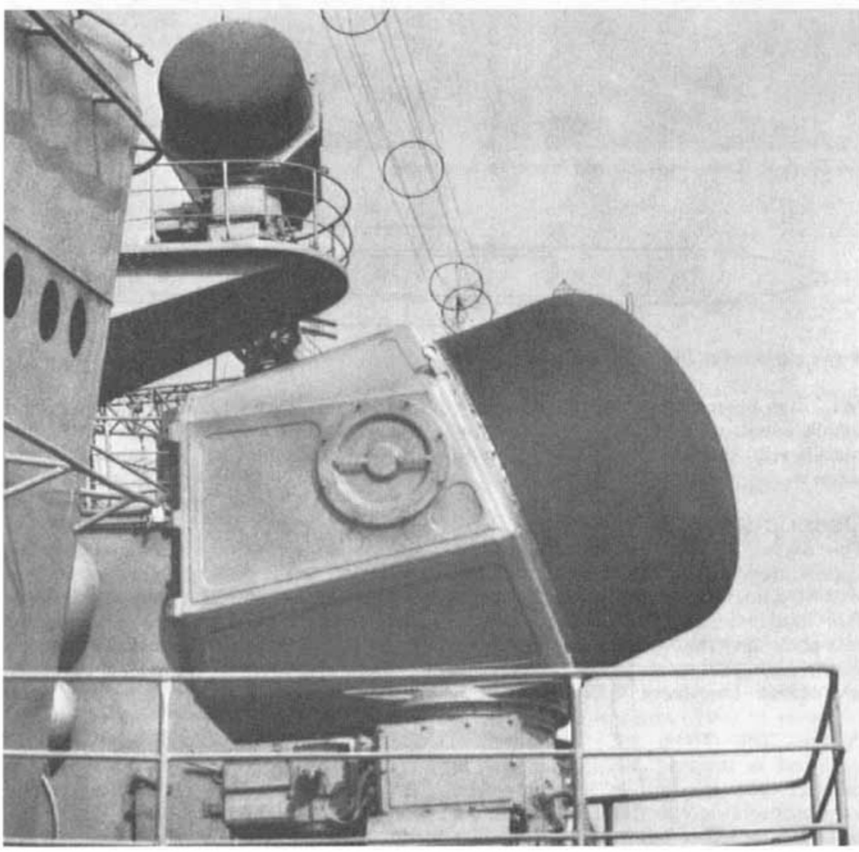
radars, as each radar directs missiles to one target.

The new SA-N-12 'Grizzly' Buk-M1-2 missiles have an increased range to 45 km and a maximum intercept altitude increased to 25 km. These missiles also have a surface-to-surface range of 25 km against ship targets, and 12 km against land targets.

Operational status

The SA-N-7 'Gadfly' entered operational service in 1981 aboard the Russian Navy's 'Sovremenny' class destroyers. It is estimated that 'Gadfly' missile production averaged 500 missiles per year during the 1980s. China, India and Ukraine have ordered SA-N-7 missile systems; the Chinese have fitted the missiles to their first two 'Sovremenny' class destroyers, and India to their three 'Delhi' class destroyers. China is reported to have ordered a further two 'Sovremenny' destroyers in 2000, with these being withdrawn from Russian service and rnodernised before delivery. India ordered three Talwar (improved 'Krivak III') frigates in 1997 with a single SA-N-7 launcher, and the first of class started sea trials in 2000. There are no other confirmed exports, although an unconfirmed report suggests that Romania has the missiles fitted to 'Muntenia' class destroyers. There were tests made in the late 1980s using the SA-I 1 missile system against both land and sea surface targets and the SA-N-7 now has a similar capability. In 1996 there were reports of SA-I 1 'Gadfly' missiles successfully intercepting Virazh-1B ballistic missile targets, at ranges of 25 km and altitudes up to 15 km. The SA-N-7 system probably has a limited capability against similar short-range ballistic threats. It is possible that the new SA-I7/SA-N-12 missile, designated Buk-M1-2, can be fitted to updated SA-N-7 launchers.

An SA-11/SA-N-7 'Gadfly' missile. shown on display at Moscow in 1992 (Christopher F Foss)



Two 'Front Dotne' engagement radars. used with the SA-N-7 'Gadfly' missile system

Specifications

Length: 5.55 m
Body diameter: 0.4 m
Launch weight: 690 kg
Warhead: 70 kg HE fragmentation
Guidance: Inertial with updates and semi-active radar
Propulsion: Solid propellant
Range: 35 krn

Associated radars
Surveillance radar: 'Top Steer' 3-D (MR-750 Fregat)
Frequency: 1-3 GHz (S-band)
Peak power: n/k
Range: 300 km

Engagement radar: 'Front Dome' (MR-90 Orekh)
Frequency: 6-10 GHz (X-band)
Peak power: n/k
Range: 30 km

Contractor

The SA-N-7 was designed by the Toropov OKB-134, Tushino and is being offered for export by the Altair NPO, Moscow. The missiles are manufactured at the Ulyanovsk Mechanical Plant.

SA-N-9 'Gauntlet' (9M330 Kinshal/9M331Tor-MI/ Klinok/9M337)

Type

Short-range, ship-based, solid-propellant, theatre defence missile.

Development

The joint development of SA-N-9 'Gauntlet' and SA-15 is the third example of Russian joint land- and ship-based surface-to-air missile system programmes. This presumably indicates satisfaction with earlier such programmes for the SA-8 and SA-N-4 'Gecko' and for the SA-10 and SA-N-6 'Grumble' systems. The Tor land-based mobile SA-15 'Gauntlet' SAM system is marketed by both Fakel MKB and the Research and Production Association Antey, part of the Ministry of Radar Industry. The ship-based SA-N-9 system, which is known as Tor-M or Kinshal in Russian service (or as Klinok for the export version), with the Russian designator 9M330 for the missile, is marketed by Fakel MKB and Altair NPO. It is believed that Fakel MKB incorporates the earlier Gushin and Bunkin OKBs, who were involved in SA-N-1 'Goa', SA-N-4 'Gecko' and SA-N-6 'Grumble' design work. SA-N-9 development took place in the late 1970s and early 1980s. It appears to have been designed to supplement the larger SA-N-6 'Grumble' system and produce a vertically launched missile with the capability to intercept sea-skimming missiles and low-flying cruise missiles. The land based SA-I5 'Gauntlet' system introduced an improved phased-array radar and missile in 1991. The new missile was designated 9M33 1 (Tor-M 1) and it is expected this has also been introduced into the SA-N-9 version.

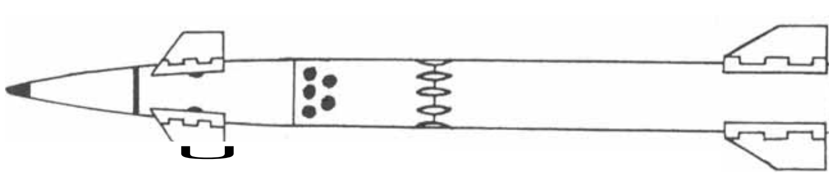
In 1996 Fakel MKB displayed an air-to-air missile based on the SA-15 design, but with an active radar seeker, and it is assumed that a follow-on design for SA-I5 and SA-N-9 will also introduce an active radar seeker. In 1999, modifications were proposed for both the missile and the supporting sensors, with the intention of increasing the missile range, the maximum altitude for interceptions and the missile flight speed. This missile has the designator 9M337.

The 'Udaloy' (Fregat type 1155) class destroyers were first seen in 1980 with mountings for two tracking radars and three hull wells for missile magazines. However, the first complete installations were not seen until 1984. Apart from the 'Udaloy' class destroyers, the SA-N-9 missiles were fitted to modified 'Kiev' and 'Kuznetsov' (Orel type 1143) class aircraft carriers and 'Neustrashimy' (Jastreb type 1154) class frigates. The 'Udaloy' class ships have eight vertical rotary launchers, each with eight missiles, making a total of 64 missiles per ship. The aircraft carriers have four groups of six vertical launchers, with a total of 192 missiles. The 'Neustrashimy' frigates have four groups of vertical launchers, with a total of 32 missiles.

Models *of* the *SA-N-9* missile and. at lower left, the eight-canister rotary launcher

Description

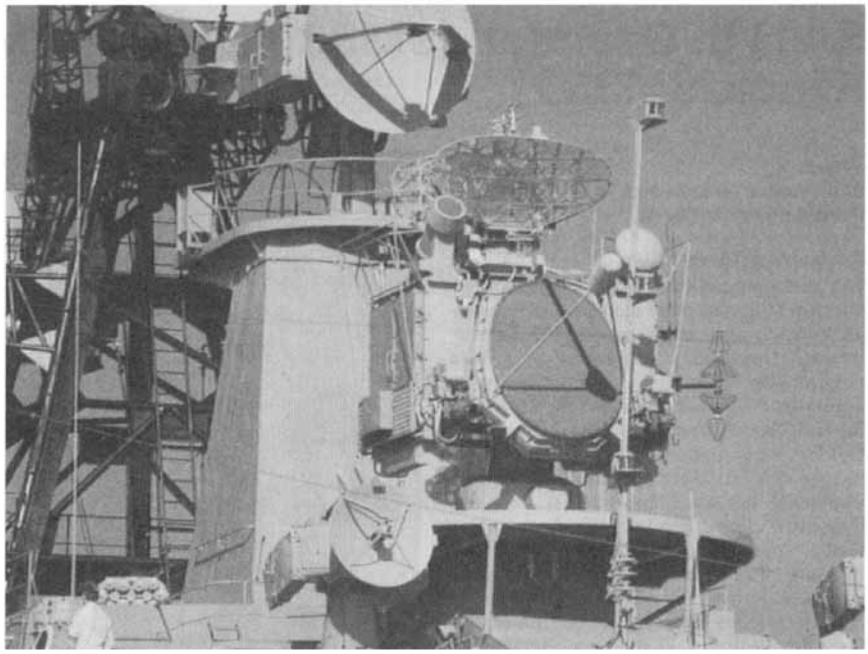
The vertically launched SA-N-9 missile has four small clipped delta control fins at the nose and four in-line clipped delta-wings at the rear. The missile is 2.9 m long, has a body diameter of 0.24 m and a launch weight of 167 kg. It carries a 15 kg HE fragmentation warhead which is activated by an RF proximity or contact fuse and the warhead is capable of being directed at the target by the proximity fuse. A solid-propellant motor gives the missile a probable range of 5 km against low-level missile targets and of 12 km against aircraft targets. The minimum range is 1 km. Altitude limits are reported to be 10 m to 6 km. The missile is ejected from its vertical launch tube to a height of 18 to 20 m before the two-stage solid-propellant motor is ignited, with the 'turn-over' of the missile controlled by lateral thrust motors near the nose of the missile. The solid-propellant motor can have two separate burning periods if required, to shape the trajectory and increase terminal velocity. The normal boost stage lasts 4 seconds and the sustain stage 12 seconds, giving the missile powered flight out to about 8 km range depending on the trajectory shape. The missile reaches a maximum velocity of 850 m/s and can manoeuvre at up to 30g. The lateral thrust motors are also used in the terminal engagement phase to improve missile manoeuvrability. The missile is advertised as having command guidance, which operates with a coded datalink, but in order to intercept missile targets it would require an active radar terminal seeker and it is believed that an active radar seeker may be fitted to later modifications. The ship installations



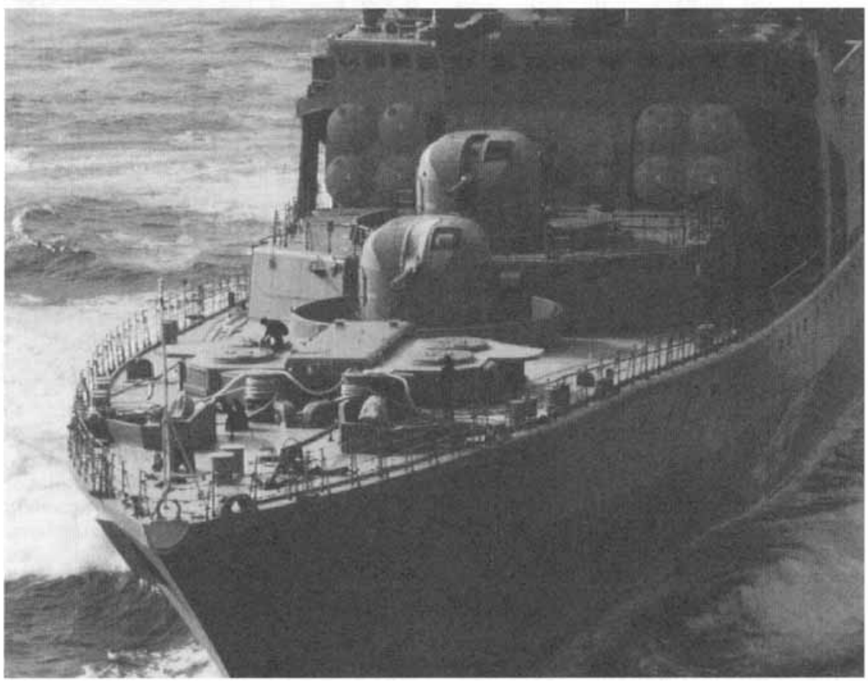
A line diagram *of* the *SA-N-9 'Gauntlet' missile*

comprise rotary magazines, each containing eight missiles, fed through between two and 24 vertical launchers with totals of between 16 and 192 missiles per ship. Missiles can be launched at 3-second intervals from the vertical launchers. Both the surveillance and engagement radars for SA-N-9 are mounted together in a single assembly, known by NATO as 'Cross Swords'. The 'Cross Swords' surveillance radar comprises two parabolic lattice antennas mounted back-to-back. The land mobile system 'Tor' has only a single antenna and the back-to-back configuration of the naval system was almost certainly adopted to provide the high data rate necessary for rapid detection and classification of low-flying aircraft and sea-skimming missiles. The monopulse radar operates at 4 to 6 GHz (C-band), like its land-based counterpart, and can provide range, azimuth, elevation and automatic threat evaluation for up to 48 targets, out to a range of 45 km.

The engagement radar employs a single large dish for target tracking, together with smaller antenna, for missile tracking and command uplink. The phased-array antennas are mounted on a structure comprising two large electronic boxes, disposed about a central pedestal. The large monopulse target tracking dish is angled at 22.5° to the vertical, has a large feed to the front and operates at 20 to 40 GHz (K-band). The naval system can track and engage four targets simultaneously and can guide two missiles to each target, provided that all targets are within the same 60 × 60" sector. Of the two enclosed drum-shaped antennas located above the main tracker, the larger presumably tracks the missile while the smaller of the two (which resembles the antenna at the base of the 'Top Dome' fire-control radar for the SA-N-6 'Grumble' area defence system), houses a guidance uplink transmitter. Both are mounted at an identical angle to the main tracker. The engagement radar can control both SA-N-9 missiles and gun systems together. At the base of the main tracking antenna, on either side, there are electro-optical TV trackers which control the actual missile guidance through a command link. An improved engagement radar was reported in 2000, the Pozitiv-ME1 radar, which operates in X-band and has a maximum range of 150 km. This radar can track up to 50 targets, and has a high elevation coverage (0to 85°). Russian reports are conflicting, but it is believed that the Russian Tor-M/Kinshal system has radar command guidance, with EO for use in ECM conditions, while the export Klinok system is only provided with the EO command guidance capability. The devices are identical in every respect and serve to reinforce the claim that two targets can be engaged simultaneously by the missile fire-control system. The Baku and *Novorossiysk* have four 'Cross Swords' radar assemblies each, located at the four corners of the superstructure.



The 'Cross Swords' surveillance and engagement radars used with the SA-N-9 'Gauntlet' missile system, showing the upper open mesh surveillance antenna, with the lower circular dish engagement radar antenna



The foredeck of the guided missile destroyer Udaloy, *with four circular hatches for the SA-N-9 vertical launch missiles located forward of the two 100 mm gun turrets* (Soviet Military Power 1987)

Operational status

The SA-N-9 'Gauntlet' system is known to have entered service in Russia in 1984 and it is thought that the SA-15 followed in 1991. The Tor SAM system with the SA-15 missile and the Klinok (Tor-M) with the SA-N-9 missile were both offered for export by Russia in 1992. SA-N-9 is believed to be in service with the Ukraine and unconfirmed reports suggest that there has been an order placed by China. In March 2000, it was reported that China will manufacture, under licence 160 SA-15 TELAR vehicles and their missiles, to supplement the 35 TELAR already purchased. It is expected that China will fit some SA-N-9 missiles to future ships. Original proposals in 1997 were to fit SA-N-9 missiles to three Indian Talwar class frigates (improved Krivak III), but on the first ship, SA-N-7 had been fitted instead. In 2001 Iran was reported to be considering an order for some SA-15 missiles, and may also order some SA-N-9 at a later date.

Specifications

Length: 2.9 m
Body diameter: 0.24 m
Launch weight: 167 kg

Warhead: 15 kg HE fragmentation
Guidance: Command
Propulsion: Solid propellant
Range: 12 km

Associated radars
Surveillance radar: 'Cross Swords'
Frequency: 4-6 GHz (C-band)
Peak power: n/k
Range: 45 km

Engagement radar: 'Cross Swords'
Frequency: 20-40 GHz (K-band)
Peak power: n/k
Range: 15 km

Contractor

The SA-N-9 missile system was designed by Antey NPO, Moscow and Fakel MKB, Khimky. Marketing of the SA-N-9 is now the responsibility of Altair NPO, Moscow. It is believed that some of the manufacture is carried out by the IEMZ-Kupol State Enterprise, Izhevsk.

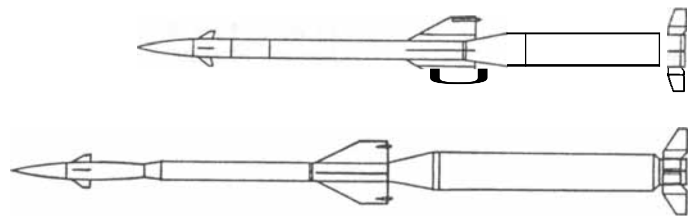
SA-N-11 'Grison' (9M311 Kortik/Kashtan and 9M335/57E6 Pantsir-SI)

Type

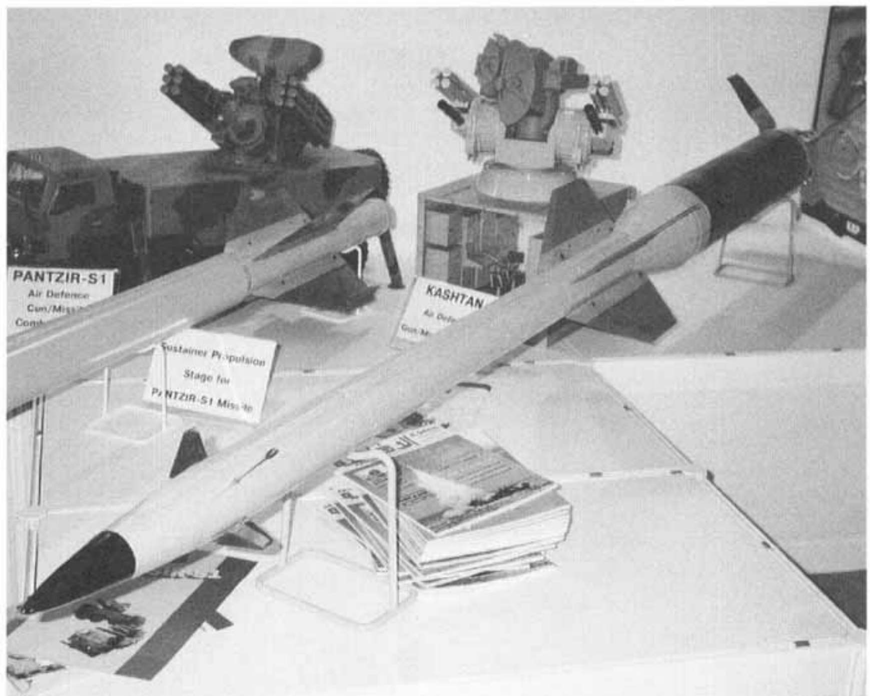
Short-range, ship-based, solid-propellant, theatre defence missile.

Development

Russia developed a tube-launched low-altitude missile, designated SA-19 'Grison' by NATO, for use with the 2S6 low-level air defence system. When used with the CADS-N-1 Russian Navy CIWS (Close-In Weapon System) it is designated SA-N-11 'Grison'. The programme appears to have been another joint Russian Army/Navy development, because SA-19 forms part of the 2S6 air defence gun/missile system, called Tunguska by the Russians and with the designator 9M311 for the missile. The Tunguska system was first identified in 1986 and was given the NATO/STANAG codename SPAAG M-1986. This system was designed as a replacement for the ZSU-23-4 Shilka, for use against low-flying aircraft and air-to-surface missiles. The CADS-N-1 system armament consists of two 30 mm Gatling type guns and eight SA-N-11 missiles, with the system given the Russian name Kortik. The export system name in Russian is Kashtan. The CADS-N-1 CIWS has been fitted to the *Admiral Nakhimov,* the third of the 'Kirov' (Orlan type 1144) class battle cruisers, with six systems, and then later to the other remaining 'Kirov' class cruiser, the *'Pyotr Velikiy'.* In 1990, eight systems were seen fitted to the aircraft carrier *Admiral Kuznetsov* (Orel class type 1143) with 256 missiles. The first 'Udaloy II' (Fregat type 1155) class destroyer has two CADS-N-1 systems fitted and the 'Neustrashimy' (Jastreb type 1154) class frigates also have two systems fitted with 64 missiles. A modified 'Tarantul II' (Molniya type 1241.1M) class missile corvette was seen in April 1992 with the CADS-N-1 system fitted and it is possible that other ships will also have the system fitted. In 1993 an improved version of SA-19/SA-N-11, called 9M335 Pantsir-SI (also designated 57E6), was exhibited in the land mobile role; and it is possible that this system might be retrofitted to ships after 2000. A heavier version, designated 57E6Y, was reported in 2001 with a range of up to 20 km.



Line diagrams of the SA-N-11 'Grison' missiles, the 9M311 (upper) and 9M335 Pantsir-SI (lower) 0054260

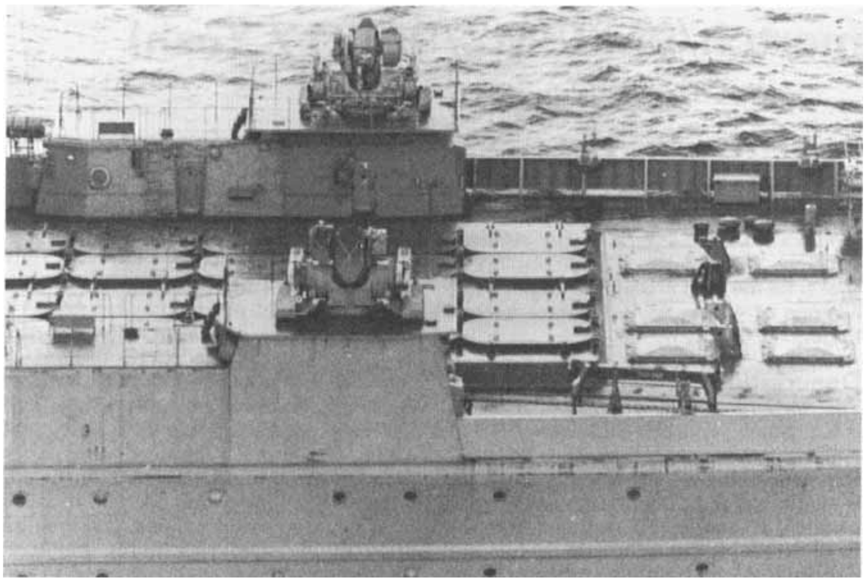


An SA-N-11 missile exhibited in 1997 (Duncan Lennox) 0010186

Description

The SA-N-11 (9M311) is a tube-launched missile, 2.63 m long, with a boost motor body diameter of 0.152 m, a second-stage (sustainer motor) body diameter of 0.076 m and a launch weight of 42.0 kg. The missile has a 9 kg HE expanding rod warhead with an active laser fuse. The missile and canister together weigh 60 kg. The missile has a two-stage solid-propellant motor, with a tandem-mounted boost motor that is jettisoned after use. The missile reaches a maximum velocity of 900 m/s, has a minimum range of 1.5 km and a maximum range of 10 km. Targets can be intercepted at altitudes between 5 and 3,500 m. The eight missiles are contained in two groups of four canisters, located outboard of the radar and tracking antenna and above the GSh-6-30K six-barrel 30 mm Gatling type guns. There are 32 reload missiles per launcher. The guns have 1,000 rounds of ammunition and a muzzle velocity of 880 m/s. The gun range is from 500 to 4,000 m, with the ability to hit targets at between 5 and 3,000 m altitude. The guns have a combined firing rate of 10,000 rounds/min. The mounting itself is notable, as it is the first time a combined gun, missile and radar system has been deployed on ships. A firing unit has an above-deck weight of 9,000 kg, a below-deck weight of 2,300 kg for the reload module and 4,500 kg for the command module. The missiles and guns are mounted on arms that swivel in elevation, the whole system rotating for direction. The SA-N-11 missile is command-guided, using either radar or EO trackers with a pulsed light source in the rear to assist the automatic missile tracking system. The operator manually tracks the target.

The CADS-N-1 system has two separate radars, with two vertical parabolic dish radar antennas mounted vertically on the pedestal. The radars have the NATO names 'Hot Flash' and 'Hot Shot' and are reported to be millimetric wave (K-band 20 to 40 GHz) with an acquisition range of 18 km. The 'Hot Flash' radar has the Russian designator 3P97. The two radars are supplemented by an electro-optical system, which it is believed includes a thermal imaging sight, a *IN* system, a laser range-finder and a laser designator. The EO system has a × 8 magnification and an 8" field of view. It is believed that the EO system can be used for passive surveillance, tracking and target designation, as well as augmenting the radars in heavy ECM conditions. A typical engagement sequence might consist of an incoming missile being detected and tracked by the large radar, the small radar being slaved to it for height and the laser for range and designation. Once the optimum distance for missile launch has been reached, either one or two missiles would be fired to intercept. Depending on whether this was successful, if the attack continued, the guns would be automatically directed and fired, either by radar or laser. Each CADS-N-1 system can



SA-N-11 Grison missile and gun Russian Naval CIWS, with the NATO designation CADS-N-1, on both sides of the Admiral Nakhimov *battle cruiser*

engage up to four incoming missiles at a time. The Russians quote a system reaction time of 8 seconds

The 9M335 Pantsir-SI version uses a larger missile (57E6), which is 3.2 m long and has a two-stage solid propellant propulsion system. This has a separating boost motor assembly with a body diameter of 0.17 m and a second stage with body diameters of 0.09 and 0 07 m. The missile has a maximum velocity of 1.1 km/s, weighs 65 kg at launch and 90 kg including its canister The warhead is a 16 kg HE rod/fragmentation type. Guidance is by command to line of sight, controlled automatically by either a dual frequency radar or a long wave IR sensor The Pantsir-SI missile has a minimum range of 1.0 km and a maximum range of 10 km, and is able to engage targets from 5 to 6,000 m altitude. An upgraded version, designated 57E6Y, has a 20 kg warhead and a weight increased to 74 kg. This version has a maximum velocity increased to 1.3 km/s, and a maximum range increased to 20 km. The Pantsir-SI version may also be fitted with a Pozitiv-ME1.2 three-dimensional surveillance/ engagement radar, which operates in X-band and can track up to 50 targets out to a range of 150 km. This radar has an elevation coverage of 0 to 85°, and rotates through 360" in azimuth. Upgraded GSh-6-30KD guns may be fitted, with muzzle velocities increased to 960 or 1,100 m/s depending on the ammunition. These guns have a maximum range increased to 5 km. The combat module weights of the Pantsir-SI system are 7,500 kg empty and 10,000 kg loaded when fitted with radar and optical guidance. If the system has only optical guidance, then the weight is 5,500 kg empty and 8,000 kg loaded.

Operational status

The SA-I9 'Grison' missile was first identified as part of the Russian 2S6 Tunguska Air Defence Gun/Missile system in 1986 and entered operational service in 1988 The CADS-N-1 system was installed on the *Admiral Nakhimov,* third of the 'Kirov' class battle cruisers, which entered naval service in 1988. The older SA-N-4 system is retained as a longer-range missile system In 1990 the aircraft carrier *Admiral Kuznetsov* was seen to have been updated by the installation of eight CADS-N-1 systems with SA-N-11 missiles, a pair of systems being located at each corner of the flight deck. It is believed that Ukraine has the SA-N-11 system in service The Pantsir-SI missile upgrade was first exhibited in 1993 and offered for export, but there is no confirmation that it has entered service in Russia, although it is possible that some SA-N-11 installations have been upgraded. The first known export order for the Pantsir-SI was made in 2000 by the UAE, with 50 TEL mounted on tracked vehicles. India is to fit two SA-N-11 Kashtan weapon systems to three Talwar class (improved Krivak III) frigates, with the first ship in service in 2002.

Specifications

Kortik (9M311)
Length: 2.63 m
Body diameter: 0.15 and 0.07 m
Launch weight: 42.0 kg
Warhead: 9 kg HE rod
Guidance: Command
Propulsion: Solid propellant
Range: 10 km

Pantsir-SI (57E6)
Length: 3 2 m
Body diameter: 0.17, 0.09 and 0.07 m
Launch weight: 65 kg (57E6), 74 kg (57E6Y)
Warhead: 16 kg HE rod/fragmentation (57E6), 20 kg HE rod/fragmentation (57E6Y)
Guidance: Command
Propulsion: Solid propellant
Range: 10 km (57E6), 20 km (57E6Y)

Associated radars
Surveillance/Engagement radar: 'Hot Flash'/'Hot Spot'
Frequency: 20-40 GHz (K-band)
Peak power: n/k
Range: 18 km

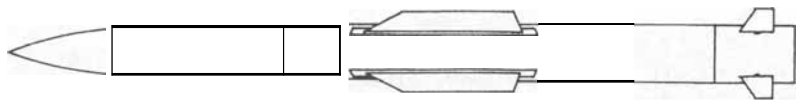
Contractor

SA-N-11 system was designed by the KBP Instrument Design Bureau, Tula and manufactured at the Ulyanovsk Mechanical Plant. It is being marketed by Altair NPO, Moscow.

SA-N-12 'Grizzly' (Smertch/9M38M2/9M317 Yozh)

Type

Short-range, ship-based, solid-propellant, theatre defence missile.



A diagram of the SA-N-12 'Grizzly' surface-to-air missile

Development

The SA-N-12 'Grizzly' missile appears to have been developed in parallel with the ground-based SA-17 'Grizzly' missile system. SA-17 'Grizzly' is an upgraded variant of SA-I 1 'Gadfly', with development probably starting around 1987. The system has been developed by Vympel NPO with support from NIIP and NIIP, building on their joint experience with SA-11. SA-17 'Grizzly' has the Russian designator Ural for the complete land-based system. The upgraded SA-11 and SA-N-7 missiles can be used with the SA-N-12 system, and these have the designator 9M38M2. An improved missile, with the designator 9M317, was developed specifically for the SA-17 and SA-N-12 systems. The SA-N-12 SAM system has been designed for use against aircraft, helicopter, tactical ballistic missile, cruise missile, air-to-surface missile and UAV targets. The system has a capability against hovering helicopters, and may well have a capability against surface targets, as has the improved SA-1 1 system. There are similarities between the SA-1 1 and SA-I 7 missiles and the US RIM-66 Standard and the SA-I 7 missile bears a resemblance to the Vympel NPO R-37 air-to-air missile. The SA-N-12 naval version has been developed and is being fitted to the later 'Sovremenny' (Sarych type 956A) class destroyers, with the Russian names Smertch or Shtil-1 for the system and Yozh for the missile. In 1997 the Russians advertised a hybrid SA-I1/SA17 system, designated Buk MI-2, with the ability to use the SA-I7 missiles from the SA-I 1 launcher and operating system. It is possible that the same might apply to the naval weapons, with SA-N-12 'Grizzly' missiles being used with the earlier SA-N-7 'Gadfly' launchers and ships.

Unconfirmed reports suggest that a further improvement to the SA-17 and SA-N-12 'Grizzly' missiles is now in development, with delta-wings for improved manoeuvrability against low-level targets and that this missile system will be known as Mysk. In 2000, Agat were reported to be developing an active radar seeker for the SA-I7/SA-N-12 missile, with a range of 40 km against fighter aircraft targets.

Description

The SA-N-12 missile, designated 9M317, is 5.5 m long, has a body diameter of 0.4 m and a launch weight of 715 kg. A 70 kg HE fragmentation warhead is fitted, but there is an option for a 50 kg warhead, which is probably an aimable HE warhead. The SA-N-12 missile is similar to the SA-N-7 but has shorter chord wings with a span of 0.86 m, is heavier and has a longer range. Propulsion for SA-N-12 is an integrated boost/sustainer solid-propellant motor that provides the missile with a peak velocity of 1.23 km/s. The missile has a minimum range of 3 km, and a maximum range of 42 km against a fighter aircraft target. The maximum range against SRBM is 20 km, which can be achieved at altitudes of between 2 and 16 km. The maximum range against small RCS cruise missiles and UAVs is between 20 and 26 km, at altitudes between 30 m and 6 km altitude. The maximum range against hovering helicopters is 42 km. The SA-N-12 missile has a surface warfare capability, with a minimum range of 3.5 km and a maximum range against ship targets of 25 km, and a maximum range against land targets of 15 km. Guidance in mid-course uses inertial plus command updates, and in the terminal phase uses a semi-active radar seeker. The missile has a storage life of 10 years in its canister, and uses a similar launcher to the SA-N-7.

The 'Sovremenny' class destroyers have 'Top Plate' 3-D surveillance radars operating in S-band for air search, with an estimated maximum range of 100 km against a fighter aircraft target. Three 'Palm Frond' C-band radars are used for surface search. Six 'Front Dome' C-band engagement radars are used for the SA-N-12 missiles, with an estimated maximum range of 60 km against fighter aircraft targets.

Operational status

Development of the SA-I7 and SA-N-12 'Grizzly' systems is believed to have started in 1987 and, as the NATO designator indicates, it is now believed to be in service. Reports from Russia indicate however that full-scale production did not start until 1995. A further improved missile is reported to be in development. There are unconfirmed reports that SA-N-12 missiles have been ordered by China, and may be fitted to the third and fourth upgraded 'Sovremenny' class destroyers, and to the second 'Luhai' class destroyer.

Specifications

Length: 5.5 m
Body diameter: 0.4 m
Launch weight: 715 kg
Warhead: 70 kg HE fragmentation or 50 kg HE
Guidance: Inertial with updates and semi-active radar
Propulsion: Solid propellant
Range: 42 km

Associated radars
Surveillance radar: 'Top Plate'
Frequency: S-band
Peak power: n/k
Range: 100 km

Engagement radar: 'Front Dome'
Frequency: C-band
Peak power: n/k
Range: 60 km

Contractors

The system has been designed by Vympel State Machine Building Design Bureau, Moscow, with support from NIIIP, Novosibirsk and NIIP, Zhukovsky. It is believed that the earlier SA-N-7 missiles were manufactured at the Ulyanovsk Mechanical Plant, and the later SA-N-12 missiles are built by Dolgoprudny Research and Production Enterprise.

SH-08 'Gazelle' (53T6, A-30)

Type

Short-range, silo-based, solid-propellant, anti-ballistic missile.

Development

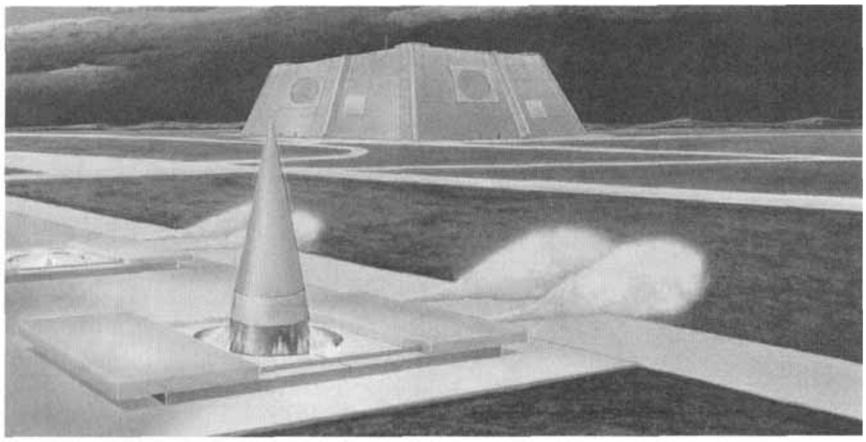
The SH-08 'Gazelle' high-acceleration missile is similar in role and performance to the US Sprint missile, which was developed in the 1960s and deployed in the USA in 1974. The 'Gazelle' missile development started in 1969 and it was not deployed until 1984, and probably represents a generation's improvement over the US Sprint missile. The first flight test was made in 1981. The SH-08 missiles form the lower tier of the Moscow anti-ballistic missile defence system. The missile is designed for endoatmospheric interception; that is, within the atmosphere (below 120 km altitude). Like the US Sprint, the 'Gazelle' is reported to be silo-based and to be armed with a nuclear warhead. It is believed that the design was modified during development to improve the capability of 'Gazelle' against IRBM threats such as the US MGM-31B Pershing 2 missile, although the more pressing threat was always the ICBMs. SH-08 'Gazelle' was deployed from 1984 as part of the Moscow ABM system, during the upgrade of this system to ABM-3 standard. It is believed that the Russian designator for this missile is 53T6, although A-30 has also been used. There are unconfirmed reports from the USA that a further development to 'Gazelle' includes an IR terminal phase seeker for more accurate guidance, and that all the missiles were modified with a fragmenting HE warhead, in place of the original nuclear warhead, in the early 1990s. A mobile TEL vehicle and trailer-mounted MARS surveillance/engagement radar with a range of 2,000 km is also believed to have been developed for SH-08, but not deployed, as this was prohibited by the 1972 ABM treaty.

It is believed that the present Moscow ABM system has the designator A-135 (5Zh60P). The command centre (5K80P) receives early warning of a ballistic missile launch from the IR sensors on geostationary Prognoz satellites, which alerts ICBM/SLBM launch posts, civil defence and ground-based radars for tracking and engagement of the attacking missile warheads. The ABM system also has optical telescopes and special radars to monitor and identify satellites in orbit.

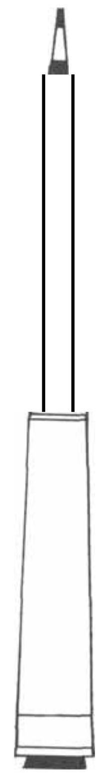
Description

The SH-08 appears to be similar to the S-300V system's SA-I2B 'Giant' (9M82) missile, and was designed by the Lyulev and Kamenev bureau (now Novatur NPO). The missile is approximately 10.0 m long and has a diameter of 1.0 m at the base. The launch weight is 10,000 kg. The original missiles had a single nuclear warhead, Russian designator AA84, with a 10 kT yield. It is believed that all the missiles are now fitted with an HE fragmentation warhead, that is probably directed to the target by command from the engagement radar. The performance attributed to the 'Gazelle' gives it the role of supporting the high-altitude SH-11 'Gorgon' missile in a two-layer defence structure. The missile has a single-stage solid-propellant motor that accelerates the missile to M10 (3 km/s) and is controlled by moving vanes in the exhaust or by thrust vector control. Guidance in mid-course is inertial with updates from the engagement radar, but the terminal phase is believed to be command guided together with warhead initiation by command. It is possible that the missiles were modified in the early 1990s with an IR seeker for terminal guidance, but this has not been confirmed. The SH-08 missile is believed to have a maximum range of 80 km, but with interceptions normally being made at 40 km altitude. The missile is silo-launched from a canister, with the silo having a special fast opening hatch. The missiles are transported on four axle-wheeled vehicles, inside their launch canisters.

The engagement radar has the NATO designator 'Flat Twin' and this is a phased array radar that tracks both the target and the 'Gazelle' missile. A 'Pawn Shop' radar provides the command update link to the missile. The 'Pill Box' (Don-2N) surveillance radar has a range of between 2.500 and 6,000 km depending on the role selection.



An artists impression of the SH-08 'Gazelle' anti-ballistic missile rising from its silo on launch



A line diagram of the SH-08 missile

0054265

Operational status

Unguided test launches of the missile were made in the late 1970s. with the first flight test made in 1981. A trial was made against two re-entry vehicles in June 1982, and SH-08 'Gazelle' is believed to have entered service in 1984. The missiles were progressively deployed around Moscow, the numbers reaching 64 missiles, although it is believed that four additional missiles were built for later flight tests. With 36 SH-11 'Gorgon' missiles deployed, this would bring the total to 100 deployed missiles, the full ABM treaty provision. SH-08 are located at eight sites around Moscow; some share the same sites as SH-11 in the outer ring at Klin, Novo-Petrovskoye, Verena and Aleksandrov, whilst the remainder are located at the inner ring sites at Schodna. Mervskino, Kaliningrad and Lytkarino. Unconfirmed US reports in the late 1980s suggested that the production of SH-08 'Gazelle' missiles had continued far beyond the numbers necessary to support the Moscow ABM-3 system. This has been denied by Russia, who claim that they have kept to the limitations of the 1972 ABM Treaty. It is possible that the similarity between the 'Gazelle' and SA-I2B 'Giant' missiles caused the confusion. In 1994, it was reported that a further improved Moscow ABM system, had been developed but not deployed. It is believed that the new system would replace or upgrade both SH-08 and SH-11 missiles. A flight test of a SH-08 missile was reported in 1993, and a further test was made from Shary Shagan in November 1999. The 1999 flight was reported to have been a life extension test of a missile taken from a

silo around Moscow, and demonstrated the capability to extend the missile life for a further 12 years.

Specifications

Length: 10.0 m
Diameter: 1.0 m
Launch weight: 10,000 kg
Warhead: HE fragmentation or 10 kT nuclear
Guidance: Inertial with command
Propulsion: Solid propellant
Range: 80 km

Contractor

It is believed that the Novatur NPO, Yekaterinburg has development and manufacturing responsibility for the SH-08 'Gazelle' missile and the Mints Radiotechnical Institute, Moscow for the radars.

SH-11 'Gorgon' (51T6, Baton/A-50)

Type

Medium-range, silo-based, solid- and liquid-propellant, anti-ballistic missile.

Development

The former USSR set out to deploy an Anti-Ballistic Missile (ABM) system around its national capital, Moscow, with design studies starting in 1954. This system was designated ABM-1 by the USA and was known as A-35 in Russia. The SH-01 'Galosh' was the original ground-based interceptor missile, later to be replaced by a two-tier system comprising the short-range SH-08 'Gazelle' and the medium-range SH-11 'Gorgon'. The SH-11 is known to the Russians as Baton. The initial system used the SH-01 'Galosh' missile on its own, with 64 missiles deployed, and possibly a further 80 missiles in reserve. The SH-01 became fully operational in 1968, but was liquid fuelled and time consuming to prepare for launch and had a large 1 MT nuclear warhead. A major modernisation programme began in 1980, which introduced the SH-11 'Gorgon'. The improvements over the SH-01 incorporated into SH-11 were: an improved smaller nuclear warhead, longer range, solid-propellant first-stage propulsion for faster reaction, silo launch for protection from attack and improved reliability. The new system was completed by 1988. The SH-11 'Gorgon' is now the medium-range ground-based interceptor, the upper tier of ballistic missile defences around Moscow, and is believed to have the Russian designators 51T6 or A-50. The short-range interceptor, known as the SH-08 'Gazelle' or A-30 system, forms the lower tier of defences.

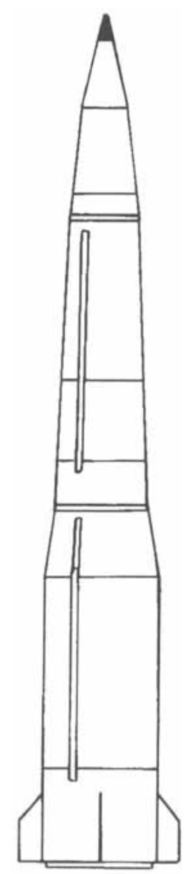
The upgraded Moscow ABM system has the designator A-135 (5Zh60P), and is known in the West as the ABM-3. It is believed that the present Moscow ABM system has a command centre (5K80P) which receives early warning of a ballistic missile launch from the IR sensors on geostationary Prognoz satellites. The centre then alerts ICBM/SLBM launch posts, civil defence and ground-based radars for tracking and engagement of the attacking missile warheads. The ABM system also has optical telescopes and special radars to monitor and identify satellites in orbit. The SH-11 could also be used as an anti-satellite missile against satellites in low earth orbit, although there has been no reported test of the missile in this mode.

Description

The SH-11 missile is 19.8 m long, with a first stage diameter of 2.57 m, a second stage diameter of 1.97 m, and a weight of 33,000 kg at launch. The payload is a single nuclear warhead with a yield of 10kT, with the designator AA84, and is the same as the warhead that was originally fitted in the SH-08 'Gazelle' missiles. The missile has two or three stages; the first stage is a solid-propellant motor for fast acceleration and the second (and third if fitted) stage uses liquid propellants for energy management and terminal phase manoeuvre. Guidance is believed to be inertial, with command updates provided by ground-based radars at the launch sites. The missile is believed to be command-guided in the terminal phase, with warhead initiation by command as well. The missile is silo-launched from its canister, with a fast opening silo hatch. This uses a cold-launch, the first-stage motor igniting when the missile is about 30 m above the silo; the missile is controlled towards interception by swivelling motor exhaust nozzles on the first stage and by four vernier motors on the second stage. The SH-11 missile has a maximum range of 350 km. The missiles are transported in their launch canisters using a six axle-wheeled vehicle, which looks similar to the MAZ-547V TEL used with the SS-20 'Saber' IRBM.

The Moscow ABM system is alerted with an early warning of a ballistic missile launch from a set of geostationary Prognoz IR satellites, and a ring of long-range (5,000 km) Daryal BMEWS ground-based radars. These phased array radars are located at Lyaki (Gabala) in Azerbaijan, at Baranovichy in Belarus, at Balkash in Kazakhstan, at Pechora in Russia, at Mishelevka in Siberia, and at Mykolayiv (Sevastopol) and Mukacheve in the Ukraine. A Daryal radar was located at Skrunda in Latvia, but this has been replaced by the radar built in Belarus. The data from these two types of early warning sensors is fed to several command and control centres, and passed to the Moscow ABM control centre to cue the engagement radars for the interceptors. Several additional long-range surveillance radars are believed to be associated with the Moscow ABM system, including 'Hen House' (Dnepr), and the Krona radar/optical system to monitor and identify satellites. Over-The-Horizon Radars (Duga) were used, but are believed to have been taken out of service in 1989. A VHF radar system, Dunai, was upgraded in 1977 and may still be in use. A large 'Pill Box' (Don-2N) four-faced phased-array radar was built at Pushkino near Moscow, entering service in 1987, and with a range of 2,500 to 6,000 km depending on its role. This dual-mode surveillance/engagement radar is believed to be the main battle management radar for the Moscow ABM system. The engagement radar used with the SH-11 'Gorgon' is

The Moscow Pill Box' radar building in the foreground, with the ABM headquarters buildings behind (Soviet Military Power 1988)
0054266



A line diagram of the SH-1 I missile
0054267

believed to be the 'Try Add' radar, which is located at each launch site and is believed to have a range of 750 km.

Operational status

The first SH-11 'Gorgon' missiles entered service when the modernisation of the Moscow ABM defences began in 1980. When this was completed in 1988, there were 36 silo-based SH-11 missiles at four sites to the north and west of the city; at Klin, Novo-Petrovskoye, Verena and Aleksandrov. There are 64 SH-08 'Gazelle' missiles also based in silos, some alongside the SH-11s and the rest at inner-ring bases. The 1972 Anti-Ballistic Missile Treaty between the former Soviet Union and the USA limited the number of missiles in the Moscow ABM system to 100. Reports in 1994 suggested that an improved Moscow ABM system had been developed, but not deployed. The new system is believed to involve the replacement or upgrading of the SH-08 and SH-11 missiles.

Specifications

Length: 19.8 m
Body diameter: 2.57 m (1st stage), 1.97 m (2nd stage)
Launch weight: 33,000 kg
Warhead: single 10 kT nuclear
Guidance: Inertial with commands
Propulsion: Two-stage solid/liquid propellant
Range: 350 km

Associated radars
Engagement radar: 'Try Add' phased-array
Frequency: n/k
Peak Power: n/k
Range: 750 km

Contractor

It is believed that the original Moscow ABM system (A-35) had been designed by a bureau headed by G V Kisunko, co-ordinated under a joint development and production organisation in Moscow. The SH-11 'Gorgon' missile was developed by Fakel MKB, Khimky. The early warning and engagement radars were developed by the Mints Radiotechnical Institute, Moscow, and the Research Institute of Long Range Radio Communications, Moscow. The radars are supported by the Radio Technical and Information Systems Joint Stock Company, Moscow.

Anti-Satellite System

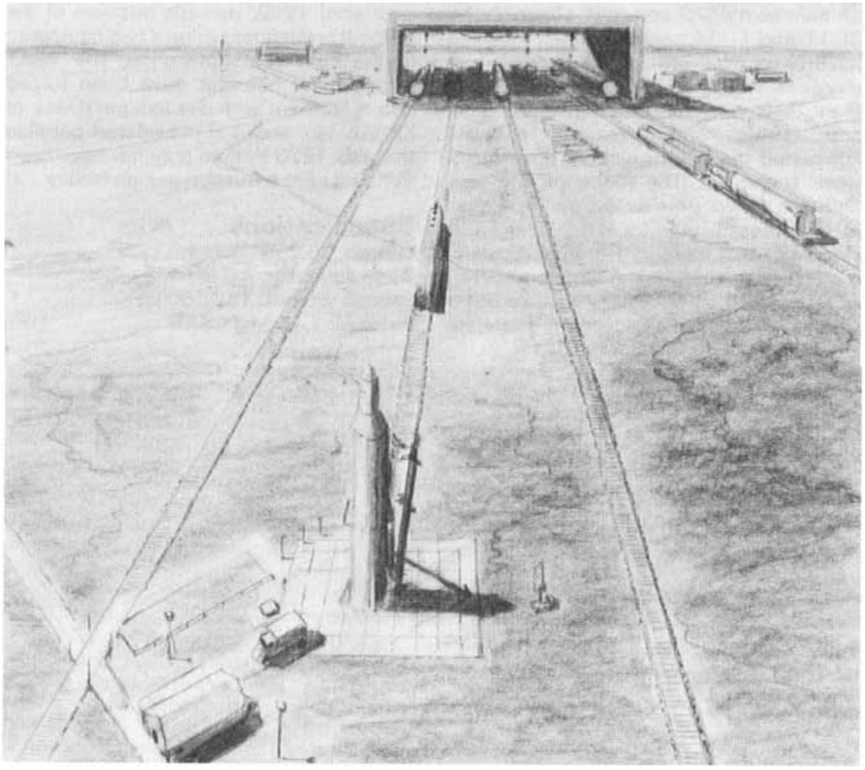
Type

Ground-launched, co-orbital, anti-satellite weapon.

Development

In the early 1960s. both the USA and the former USSR were developing ballistic missiles. The approach to the requirement for an Anti-SATellite (ASAT) system was to utilise the same technology; using missile boosters to carry satellites with warheads into orbit and placing them in the same orbit as the target (hence co-orbital ASAT), gradually drawing sufficiently close to destroy them with a fragmenting warhead. At that time, satellites had little capability for evasive manoeuvre and there would have been insufficient time to respond to an ASAT attack, even though these took some hours to be mounted.

The first flight tests of a Russian ASAT system took place in 1968, using both optical and radar terminal homing systems. The final system was developed to use the SL-11 Tsyklon space-launcher vehicle as the boost motor stage, and was deployed in 1971. The primary purpose was to provide the ability to attack satellites in low earth orbit, although longer-range capabilities were ascribed to the system by some reports from the USA. Article VII of the 1987 INF Treaty specifically included reference to the use of banned IRBM as direct ascent ASAT vehicles. It is assumed that the former Soviet Union had planned to use modified SS-20 'Saber' first- and second-stages as a follow-on ASAT system, although this has never been confirmed. The USA probably considered using MGM-31 Pershing missiles, also banned by the INF Treaty, as ASAT vehicles, but this has never been confirmed. The USA has maintained a research capability into ASATs, although no flight tests have been made by either the Russian Federation or the USA since 1985. It is expected that Russia has maintained an ASAT technology capability, and would test this if the USA were to resume tests. Russia could adapt some S300V (SA-12B 'Giant'), SS-25 'Sickle' (RS-12M Topol) or SS-27 (RS12M1 Topol-M) missiles into the ASAT role.

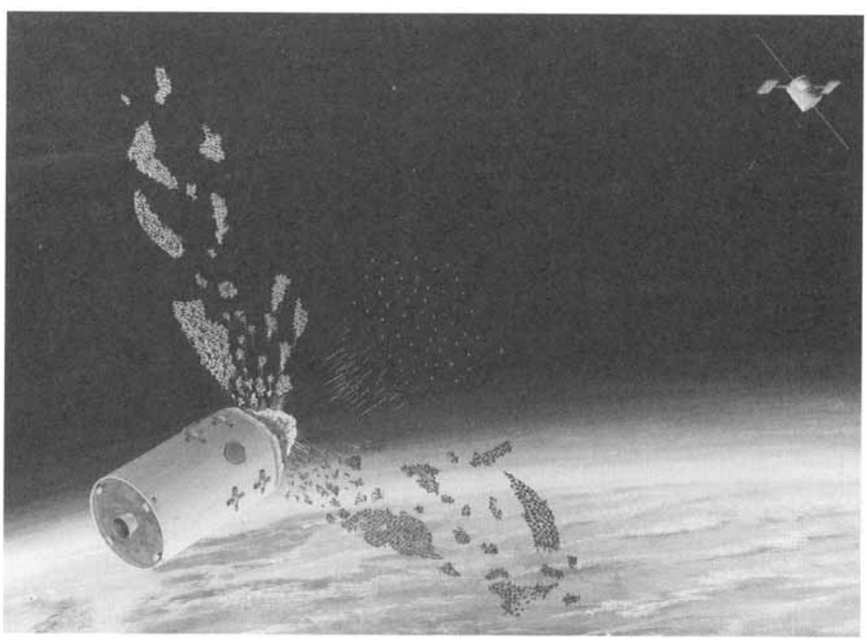


An artists concept of the Tyuratarn ASAT launch facility

Description

It is reported that the actual interceptor portion of the ASAT is about 4.2 m long, with a body diameter of 1.8 m and a weight of approximately 1,400 kg. The Russian ASAT system depends on an active radar seeker to guide the HE fragmentation warhead to its target. Although six trials were made with electro-optical seekers they are all believed to have failed. The interceptor can attack a target in various orbits during the interceptor's first two orbits, but has to compromise accuracy for time, the target being able to take evasive action unless the intercept is made during the first orbit. The Russian ASAT was designed to attack satellite targets in low earth orbit, probably from altitudes of between 150 and 500 km.

The SL-11 ASAT carrier vehicle is launched from Tyuratam (Baikonur), where there are several launch pads and storage for launchers. According to US sources this could provide a launch rate of several ASATS per day. The SL-11 booster was based upon the SS-9 'Scarp' ballistic missile, which was a two-stage liquid-propellant ICBM. SL-11 (Tsyklon) was introduced as a satellite launch vehicle in 1966, and there have been around 130 launches. SL-11 was designed to lift a payload of up to 3,000 kg into low earth orbit; it has a total length of 35.0 m, a body diameter of 3.0 m and a launch weight of around 182,000 kg. A third stage was added to the SL-11 to create the SL-14 satellite-launch vehicle, which was first launched in 1977. This satellite-launch vehicle has made around 120 launches, and can carry a payload of 3,600 kg into low earth orbit.



An artists impression of the fragmentation warhead of the Russian ASAT approaching a satellite target

Operational status

The US authorities claim that the Russian system became operational in 1971, using

a single launch area at the Tyuratam Flight Test Centre in Kazakhstan. There have been no reported flight tests since 1982, perhaps in response to the US moratorium on their own ASAT activities, although the SL-11 and SL-14 satellite-launch vehicles have been used regularly to launch civil payloads into space. A total of 20 ASAT flight tests were reported between 1968 and 1982, and Western analysts suggested that about nine of these tests were successful. The range of intercept altitudes varied, from as low as 150 km to an unsuccessful attempt at 1.710 km. The system cannot be regarded as particularly credible in threat terms. A large number of ASATs would be necessary to take out a useful proportion of an adversary's satellite capability and this is not likely to be achieved before the launch sites could be attacked themselves. The Russians are believed to have maintained the system at least until 1992, perhaps because of the political and military value it had compared to the cost of maintenance. The ASAT system may however have been forced into retirement with the independence of Kazakhstan, and it is considered possible that this 1970 system may not have been transferred to a Russian launch facility.

Specifications

Length: 35.0 m
Body diameter: 3.0 m
Launch weight: 182,000 kg
Payload: 1,400 kg ASAT
Warhead: HE fragmentation in ASAT
Guidance: Inertial and active radar or EO
Propulsion: Four-stage liquid propellant
Range: 5,000 km

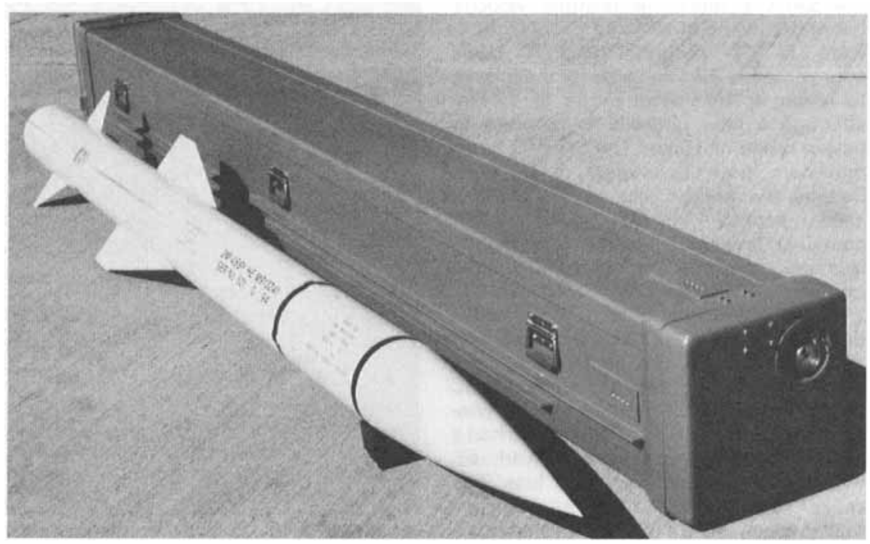
Contractor

It is believed that the ASAT was developed by the Kometa NPO, Moscow. The SL-11 launch vehicle was developed from the SS-9 'Scarp' ICBM, designed by the Yangel (now Yuzhnoye NPO) OKB.

SAHV-3/-IR/-RS, Umkhonto

Type
Short-range, ground- and ship-based, solid-propellant, theatre defence missiles.

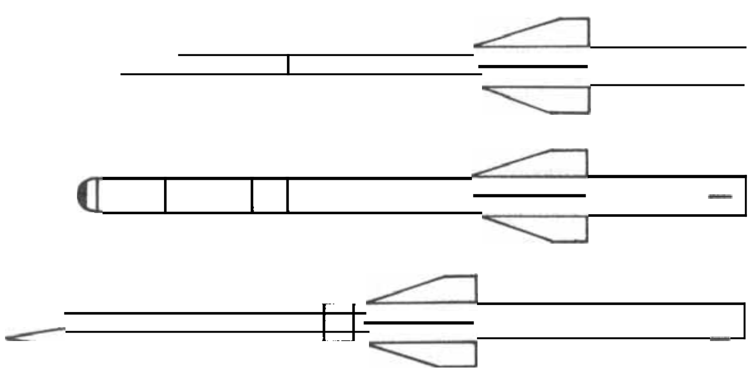
Development
The South African SAHV-3 (Surface-to-Air High Velocity-3) missile programme was initiated in the mid-1980s. during the final phase of the Angolan campaign, when the South African National Defence Force (SANDEF) found that it could not provide sufficient air cover for its ground troops. The missile, believed to have been called Spectre, was designed as a plug-in replacement for the French Cactus/Crotale missiles, and SAHV is compatible with the Crotale fire unit including the command link receiver. A common RF/laser command link is used in both the Crotale and SAHV-3 systems, and the laser option has been incorporated in the baseline SAHV-3 model to ensure compatibility with the passive electro-optical tracking system specified by the South African Army. The first projected platform for the SAHV was Crotale 1000, a modernised version of the Cactus missile system in service with the SANDEF, but the latest version is Crotale 4000. The SAHV missile was designed to take alternative guidance systems, using assemblies already in development. The first option uses command guidance from the Crotale system, and is known as SAHV-3. A second option uses an IR homing seeker developed for the Darter air-to-air missile, and this variant was initially designated SAHV-IR, but is now known as Umkhonto (Spear). A third option, which employed an active radar seeker, was designated SAHV-RS. Models of these three versions were first displayed at exhibitions in 1991, but only the SAHV-3 version was built for production. The SAHV is expected to provide a complete air defence system against low-flying fixed-wing aircraft, helicopters, UAVs and guided missiles. The Umkhonto missile was first exhibited in 1998, following a development contract placed with Kentron a year earlier. This version is a vertically launched ship-based surface-to-air missile, based on the SAHV-IR design. It has been ordered for fitting on four MEKO A200 class corvettes, with 16 or 32 missiles planned per ship.


An SAHV-3 command guided missile beside its container (Kentron) 0054270

An Umkhonto naval surface-to-air missile at launch (Kentron) *2000*/0085247

Kentron is already proposing further variants to meet different applications and customer requirements, including an air-to-air medium-range active radar (SAHV-RS) version and an active radar longer-range version of the Umkhonto missile known as Umkhonto-R. It is reported that Umkhonto-R will have a range increased to 15 km, and later possibly to 25 km. By adding ramjet propulsion, it is envisaged that the missile could in future provide the basis for a medium-range SAM. In 1994, Kentron and Oerlikon-Contraves (now part of Rheinmetall AG) offered an eight-missile launcher with SAHV-IR missiles as an additional upgrade for existing 35 mm cannon Skyguard AAA defence systems.

Description
The basic SAHV-3 missile is an Automated Command to Line Of Sight (ACLOS) guided



3.13 m long, has a body diameter of

radar fuze. The missile is fitted with optical

by a low-smoke solid-propellant motor, which accelerates the missile to a maximum speed of M3.5. It is reported that the SAHV-3 retains a residual velocity better than M1.5 at 12 km. Time of flight to 8 km is 10 seconds, and it takes approximately 17.5 seconds for the missile to reach its maximum range of 12 km, although a later upgrade is reported to have a range of 15 km. The SAHV-3 has a maximum intercept altitude of 7,500 m. Despite the greater size of the SAHV-3 itself, packed in its square-section container/launcher, it is actually slightly less bulky than the original R-440 Cactus missile.

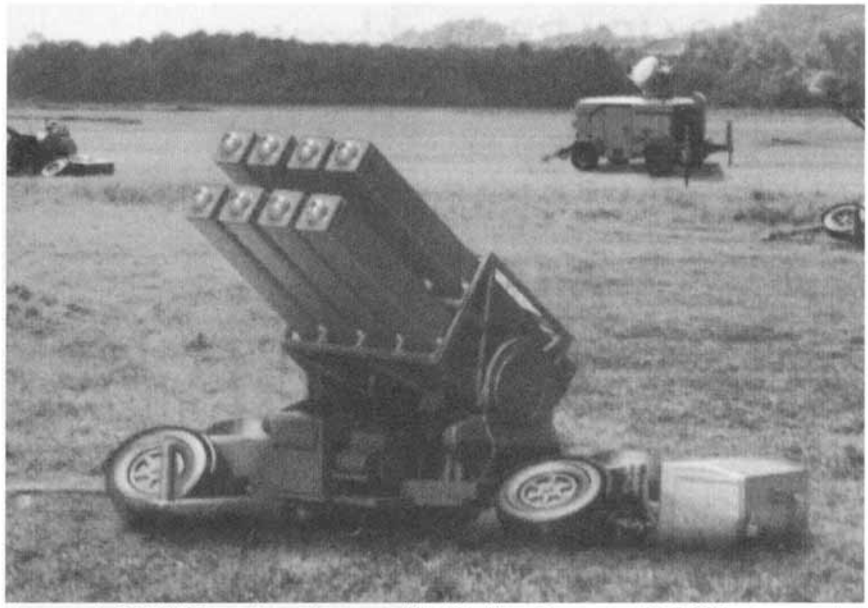
The SAHV-IR was 3.36 m long, had a body diameter of 0.18 m and weighed 120 kg at launch. The guidance system, which was derived from the air-to-air V3C Darter missile, was inertial, with a two-colour IR-homing seeker. The missile had a 20 kg HE blast/fragmentation warhead, with an active laser proximity fuse. The seeker system also featured an autoscan reacquisition and a 100° cone scan sector. The SAHV-IR missile was transported, stored and fired from a box launcher, which could be fitted to the simplest of pedestals. The missile would normally be launched using inertial guidance with updates from the launcher, with a lock after launch capability from the terminal IR seeker. For short-range targets the IR seeker could be locked before launch. SAHV-IR had a maximum range of 10 km and could intercept targets flying at altitudes of between 10 and 6,500 m. Missiles could be launched from an eight-canister modified Oerlikon-Contraves GDF-005 gun carriage. The SAHV-IR missile had a slower speed than the basic SAHV-3 missile and took 14 seconds to fly out to 8 km.

The SAHV-RS was 3.6 m long, but the body diameter and layout were the same as for the SAHV-IR. As a result of the increased size and a larger 23 kg HE warhead, this variant weighed 137 kg at launch. The missile had inertial guidance and the terminal seeker was a fully active pulse Doppler radar, with a 90° scan cone and a home-on-jam mode. The missile radar was reported to be capable of detecting an approaching 250 m/s target out to 10 km and a departing target to about 8 km, with a maximum intercept altitude of 7 km. Coupled with a tracking radar, this version could be used in the lock-on after-launch mode. The missile had a maximum range of 13 km.

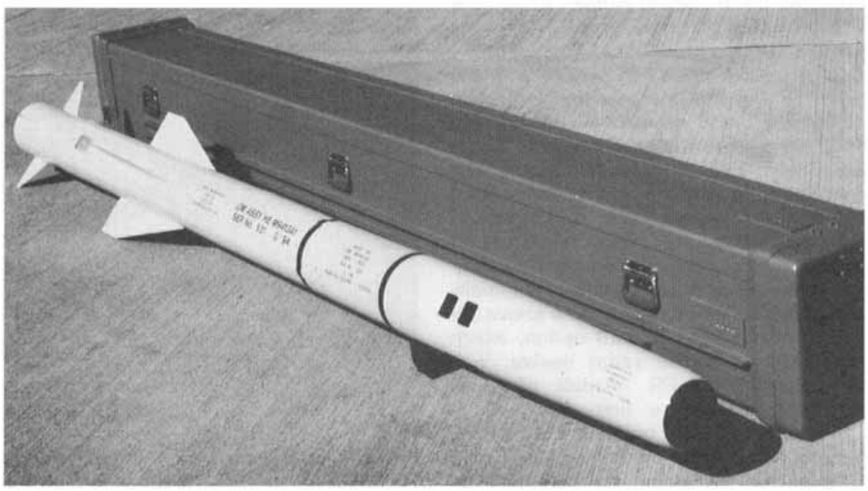
The Umkhonto missile is an improved version of the SAHV-IR, developed specifically for use from ships, but with a new boost motor assembly for vertical launch. The missile has a length of 3.3 m, a body diameter of 0.18 m, a wing span of 0.4 m and a launch weight of 125 kg. The warhead is a 23 kg HE blast/fragmentation type, with an active proximity fuse that is believed to be a radar fuze. Guidance is inertial in mid-course with updates from the engagement radar, and with an IR seeker for the terminal phase. The IR seeker can be locked onto the target at the end of the mid-course phase, or for short-range targets can be locked on before launch. The boost motor has thrust vector control to turn the missile towards the target after vertical launch, then control is by four moving rear fins. The missile takes 15 seconds to reach 8 km, and has a maximum range of 12 km. Umkhonto can intercept targets at altitudes between 10 and 7,500 m. The missiles are fitted in groups of four canisters, with each canister having a weight of 165 kg.

The surveillance radar used with the SAHV missile system is usually the Reutech Radar Systems ESR220 Kameelperd, which operates in the C-band (4 to 6 GHz), can track up to 100 targets, and has an acquisition range of 65 km. This 3-D phased array radar is mounted on a four-axle truck chassis, and is C-130 Hercules transportable. The EDR 110 engagement radar also operates in C-band and has an acquisition range of 20 km.

SAHV missiles can be fitted to the Self-Propelled Surface-to Air Missile (SPSAM) vehicle. The three elements of the self-propelled air defence system are the twin 35 mm gun vehicle, the SPSAM vehicle and surveillance radar. The gun and SAM vehicles use the same stretched ROOIKAT hull and the same turret, radar and electro-optical fire-control system. The SPSAM system has a pair of missile canister launchers on each side of the turret.



An octuple SAHV-IR launcher using a modified Oerlikon Contraves GDF-005 gun mounting (Kentron) 0054269



An SAHV-IR missile beside its container (Kentron) 0054271

Operational status

The SAHV-3 missile was first test fired in September 1990 and is expected to complement and gradually replace the Cactus/Crotale R-440 missile. It is also being incorporated into the new South African Army mobile air defence systems, the ZA-35 and ZA-HVM vehicles. The SAHV-3 system is reported to have entered service in South Africa in 1994, replacing Cactus/Crotale, but there are no known exports. The Umkhonto ship-based SAM version was first tested in 1999, and is planned to enter service in 2004 on the MEKO A200 class corvettes.

Specifications

	SAHV-3	SAHV-IR	SAHV-RS	Umkhonto
Length	3.13 m	3.36 m	3.6 m	3.3 m
Body diameter	0.18 m	0.18 m	0.18 m	0.18 m
Launch weight	115 kg	120 kg	137 kg	125 kg
Warhead	20 kg HE frag	20 kg HE frag	23 kg HE frag	23 kg HE frag
Guidance	ACLOS	inertial with updates and IR	inertial with active radar	inertial with updates and IR
Propulsion	solid propellant	solid propellant	solid propellant	solid propellant
Range	15 krn	10 km	13 krn	12 krn

Associated radars
Surveillance: ESR 220
Frequency: 4 to 6 GHz (C-band)
Peak power: n/k
Range: 65 krn

Engagement: EDR 110
Frequency: 4 to 6 GHz (C-band)
Peak power: n/k
Range: 20 km
Optical tracker: AA-EOT

Contractor

Kentron Divison, Denel, Centurion.

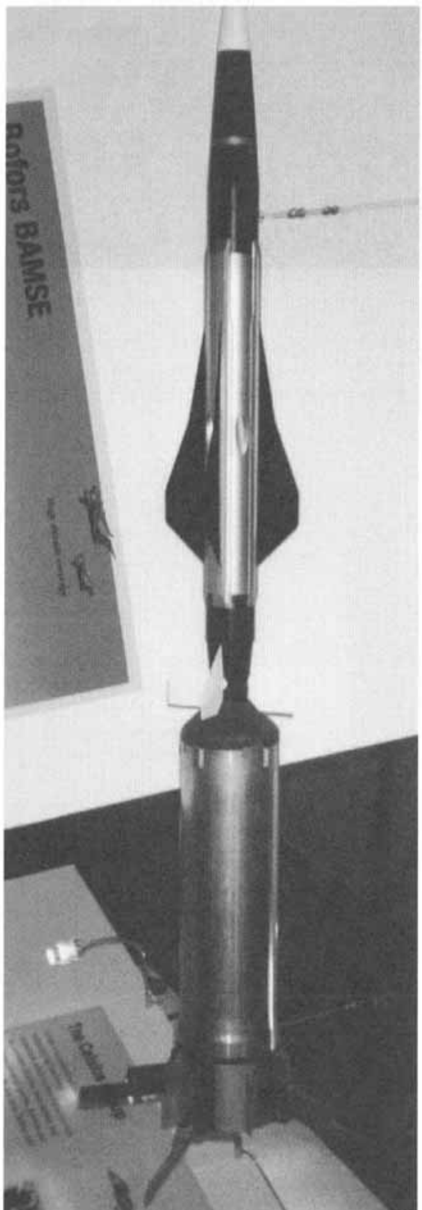
A command-guided** SAHV-3 **missile being launched from a Crotale TEL vehicle (Kentron)
0054268

RBS 23 BAMSE

Type
Short-range, ground- or ship-based, solid-propellant, theatre defence missile.

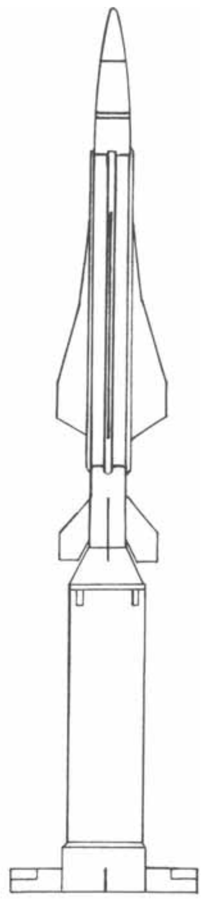
Development
A development contract was placed in May 1993 by FMV Sweden, to develop the Bofors Advanced Medium-range Surface-to-air Evaluation (BAMSE) missile system. This was given the Swedish Army designator RBS 23, and was designed to defend against aircraft, helicopters, cruise missiles, UAV, ASM and guided bombs. The first trials launch was made in October 1994, with further development and evaluation firings up to December 1998. The initial design was for a two-stage missile to be deployed on a towed trailer. In 1997, it was proposed to adapt the design for fitment to the 'Visby' class corvettes, using a cold-launch technique with the boost motor igniting when the missile reached a height of 5 m. The ship-launched version has been called BAMSEA. In 1999, a proposal was made to adapt the missiles and engagement radar to fit onto a wheeled TEL, in response to a request from Poland.

Description
The RBS 23 missile has two stages. The first stage contains the solid-propellant boost motor, which has four rectangular flip-out fins at the base. The boost motor burns for less than a second, accelerates the missile to 900 m/s, and is then jettisoned. The second stage has two



A RBS 23 BAMSE missile displayed in September 1999 (Duncan Lennox)
200110105783

A surveillance co-ordination centre vehicle with an AMB Giraffe radar antenna on a raised mast (Saab Bofors Dynamics)
2001/0105782



A line diagram of a RBS 23 missile
2001/0105781

clipped-tip delta wings at mid-body, and four moving control fins at the rear. The second stage has an HE fragmentation and shaped charge warhead, an active laser proximity fuze and an impact fuze. The solid-propellant sustainer motor maintains the missile speed at 900 m/s, whilst it is burning. The second stage has radar CLOS guidance, provided by the engagement radar and command uplink. The total missile has a length of 2.6 m, the first stage has a body diameter of 0.21 m, and the second stage has a body diameter of 0.11 m. The launch weight is 85 kg, and the maximum range is 15 km. The missile can intercept targets at altitudes between 25 m and 15 km.

The missile launcher is called the Missile Control Centre (MCC), and this is a towed trailer. The development MCC has four missile canisters mounted in pairs, and each pair is elevated before missile launch. The production MCC will have six missile canisters. There are two operators, and they can control two engagements. The trailer is NBC protected, and six missiles can be reloaded in three minutes. An elevated 8 m mast on the MCC carries the improved Ericsson Eagle engagement radar antenna, which is a Ka-band (35 GHz) radar with a range of 30 km against fighter aircraft targets. Mounted on the same mast is an IFF system, a TV/IIR sensor and a weather monitoring system. The MCC also has its own simulator for operational training, and a real-time engagement recorder. The towing vehicle can carry missile reloads. and the vehicles are C-130 Hercules transportable. The MCC can be set up and operational within 10 minutes. The MCC can be linked by fibre optic cable and/or microwave radio link to the Surveillance Coordination Centre (SCC), and can be up to 20 km apart. Each MCC can be separated by up to 15 km. A typical BAMSE battery would have one SCC and two to four MCC.

RBS 23 missile control centre, with four missile canisters and the sensor mast erected (Saab Bofors Dynamics)
2001/0105784

The surveillance radar is carried on a Surveillance Co-ordination Centre (SCC) vehicle, which is a Scania three-axle truck with a standard six metre ISO container. The vehicle carries a 35 kVA diesel powered electrical generator, is NBC protected, and can have a crew of two or three operators. The surveillance radar is an Ericsson Agile Multi-Beam (AMB) Giraffe 3-D stacked beam system, operating in C-band between 5.4 and 5.9 GHz. The antenna is mounted on an extending mast that can be set at 8 or 12 m, and the antenna rotates at 60 rpm. The surveillance radar has a range of 100 km against fighter aircraft, and has an altitude limit of 20 km. The radar beam can cover elevation angles from 0 to 70°. The SCC operates as a command and control centre, with usually up to four MCC attached. Up to 100 targets can be tracked, and the system can be set up and operational within 10 minutes. The SCC is C-130 Hercules transportable.

Operational status

The first flight trials with RBS 23 BAMSE were made in 1994, and development evaluation firings continued until December 1998. Operational evaluation started in 1999 and completed in June

2000. A full production order was placed in July 2000, with a planned purchase of three batteries with nine MCC and three SCC. The first units are planned to enter service in March 2003. It is also expected that the RBS 23 system will be adapted and fitted to some of the 'Visby' class corvettes to be delivered to the Royal Swedish Navy. Any BAMSE fitted in the corvettes is expected to be interchangeable with the helicopter and hangar, but the selection has not yet been announced. The first ship is expected to enter service in 2005.

Specifications

Length: 2.6 m
Body diameter: 0.12 m (1st stage), 0.11 m (2nd stage)
Launch weight: 85 kg
Warhead: HE fragmentation
Guidance: Radar CLOS
Propulsion: Two-stage solid propellant
Range: 15 km

Associated radars
Surveillance radar: Ericsson AMB Giraffe 3-D
Frequency: C-band (5.4 to 5.9 GHz)
Peak power; n/k
Range: 100 km

Engagement radar: Ericsson Improved Eagle
Frequency: Ka-band (35 GHz)
Peak power: n/k
Range: 30 km

Contractors

Ericsson AB, Molndal (radars).
Saab Bofors Dynamics, Karlskoga. (prime contractor).

Sky Bow 1, 2 and 3 (Tien Kung)

Type

Short-range, ground-based, solid-propellant, theatre defence missiles.

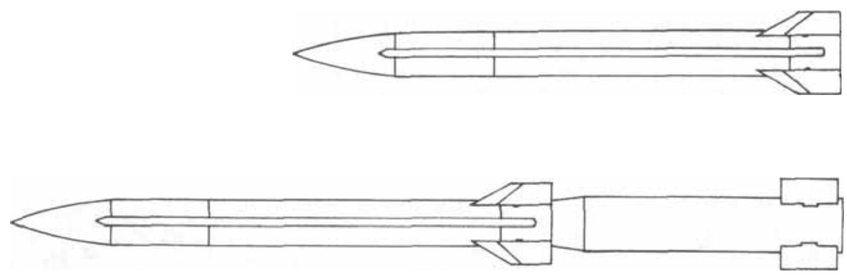
Development

In the mid-1970s the Chung Shan Institute of Science and Technology began work on a new surface-to-air missile system for the Taiwanese Army, that was based on the I-HAWK missile. However, due to the acquisition of more sophisticated missile technology in the form of an 85 per cent transfer from Raytheon and the US government of the MIM-104 Patriot design, the Chung Shan Institute was directed to stop work on this earlier programme and, in 1981, started development of the Tien Kung 1 (Sky Bow 1) missile system. It is believed that this missile may have been renamed Chungcheng 100, but there is no confirmation of this. Firing trials for Sky Bow 1 started in March 1985, using a semi-active radar seeker. A passive IR terminal seeker was also developed as an alternative, and this was successfully tested against a HAWK missile target. The Chung Shan Institute also developed a phased-array radar for use with Sky Bow 1, which is mobile and can provide all-round radar cover with four separate faces.

It is believed that the development of Sky Bow 2 started around 1986, and this added a tandem boost motor and an active radar terminal seeker. Proposals were reported to develop Sky Bow 2 into a surface-to-surface missile, but it is believed that this programme was not funded. Modifications have been developed for Sky Bow 2 to provide it with a limited capability against shorter-range ballistic missiles, and the first test firing against a ballistic missile target was made in May 1998. Further tests were reported in July 1998 and September 1999, although it is possible that the last test might have been by a prototype Sky Bow 3 missile.

A third version, called Sky Bow 3, is reported to be in the development stage, and is expected to continue even though Taiwan has received MIM-104 Patriot missiles. The principal requirement is for a defence against Chinese ballistic and cruise missiles, and it is believed that Sky Bow 3 is a development for a smaller missile similar to the US PAC-3 missile. In order to achieve a greater range, it is believed that ramjet propulsion is to be used for Sky Bow 3. An advanced IR seeker is believed to be in development, possibly as a dual-mode IR/active radar seeker to give Sky Bow 3 a better capability against both ballistic and cruise missiles. It is possible that the first flight test of Sky Bow 3 was made against a cruise missile target in September 1999, although some reports stated that this was a further test of Sky Bow 2. Reports in 1996 suggested that Taiwan might purchase the Australian (Telstra Applied Technologies) HF surface wave radar for early warning of ballistic and cruise missile attacks, to cue the Sky Bow and Patriot radars.

Sky Bow 1 missiles on a demonstration launch vehicle



Line diagrams of the Sky Bow 1 (upper) **and** *Sky Bow 2 (lower) missiles*

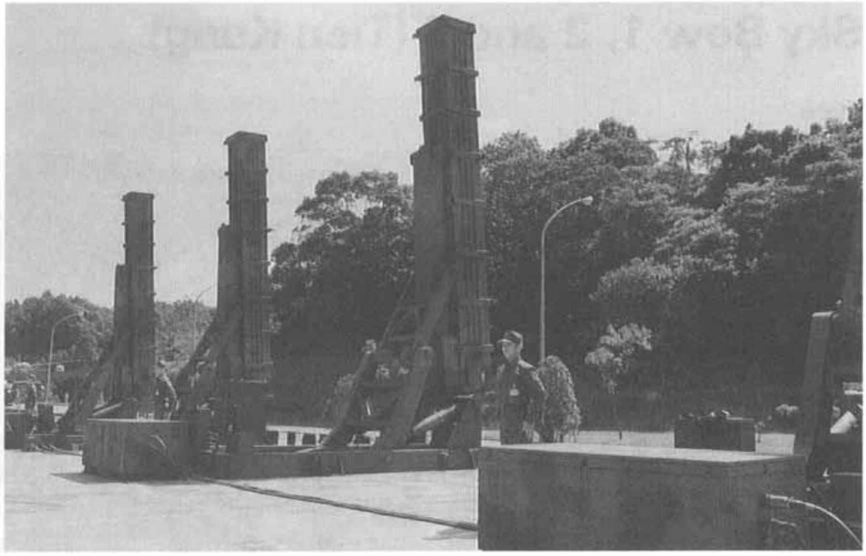
Description

Sky Bow 1 is a hybrid system, combining elements of the US-designated MIM-104 Patriot (launcher, dimensions and airframe) and the US-designed MIM-23 Improved HAWK (electronics), with performance characteristics falling between the two. The missile has four moving clipped delta-fins at the rear, an overall length of 5.3 m and a body diameter of 0.41 m. The launch weight is in the order of 915 kg, with a 90 kg HE fragmentation warhead. Guidance in mid-course is inertial with command updates, with semi-active radar or IR terminal-guidance For the target acquisition, tracking and mid-course missile guidance requirements, the Sky Bow system uses a 4 × 4 truck-mounted container, with an ADAR-1 four planar multi-element phased-array antennas mounted on each face of the retractable 'tower' The radar provides 360" coverage over a range of 450 km. The ADAR-1 Chang Bai (Long White) radar operates at around 3 GHz (S-band). The 'tower' is only elevated for use when the vehicle is placed at a missile site. For illumination of targets during the terminal attack phase, a CS/SPG-24 CW radar is used, and this operates at 8 to 12 GHz (X-band) with a maximum range of 200 km. This is believed to be tied into the phased-array system on a similar time-sharing manner to that employed in the US Navy's shipborne AEGIS air defence system, to allow multi-engagement of targets. Each Sky Bow 1 battery is believed to have one Chang Bai surveillance radar, two CS/SPG-24 engagement radars and four launcher vehicles each with four missile canisters. The trailer-mounted launcher station is almost identical to that used for Patriot except in minor details such as frangible covers on the four container launcher boxes The missile has a single-stage solid-propellant boost and sustainer motor, with

The Sky Bow four-faced phased-array radar and truck, with the radar antenna raised for ***use***

a maximum missile speed of M4.0. Sky Bow 1 has a maximum range of 70 km, with a minimum intercept altitude of 100 m and a maximum of 24 km.

Sky Bow 2 is identical in appearance to Sky Bow 1, with the addition of a tandem jettisonable booster with four in-line rectangular stabilising fins. The missile has an overall length of 8.1 m, a body diameter of 0.41 m and with a 90 kg HE fragmentation warhead weighs 1.115 kg at launch. Sky Bow 2 has an improved guidance system that incorporates an active radar terminal seeker, and uses a vertical-launch system. The maximum-range has been extended to 150 km and the maximum intercept altitude to 30 km. A modified version has been developed for use against shorter-range ballistic missiles, with larger warhead fragments and a new fuze.



Sky Bow 1 launch canisters on display

Operational status

Sky Bow 1 is in production and entered service with the Taiwanese Army in 1988. Sky Bow 2 first trials firings were reported in 1988 and the system is believed to have entered service in 1995. A modified version of Sky Bow 2 was tested against ballistic missile targets in 1998 and 1999. It was announced in 1989, that Taiwan planned to build 900 Sky Bow 1 and 2 missiles at a rate of 100 per year, and it is believed that the development and testing continued until 2000. Six Sky Bow 1 and 2 batteries have been deployed at Penghu, Taichung, Sanchih, Tungyin (Matsu Islands) and two near Kaohsiung. It is reported that the missiles are deployed in underground cells, with four missiles per cell, protected by 1 m thick concrete walls. Development of Sky Bow 3 is believed to have started in 1996, and it is expected that this missile will be smaller than Sky Bow 1 with ramjet propulsion. A possible flight test of a prototype missile was reported in September 1999, and Sky Bow 3 is planned to enter service in 2005/2006.

Sky Bow 2 missile with tandem jettisonable booster motor

Specifications

Sky Bow 1
Length: 5.3 m
Body diameter: 0.41 m
Launch weight: 915 kg
Warhead: 90 kg HE fragmentation
Guidance: Command, inertial and semi-active radar or IR homing
Propulsion: Solid propellant
Range: 70 km

Sky Bow 2
Length: 8.1 m
Body diameter: 0.41 m
Launch weight: 1,115 kg
Warhead: 90 kg HE fragmentation
Guidance: Command, inertial and active radar
Propulsion: Solid propellant
Range: 150 km

Associated radars
Surveillance radar: phased-array ADAR-1 Chang Bai
Frequency: 3 GHz (S-band)
Peak power: 1 MW
Range: 450 km

Engagement radar: CS/SPG-24
Frequency: 8 to 12 GHz (X-band)
Peak power: n/k
Range: 200 km

Contractor

Chung Shan Institute of Science and Technology, Taipei.

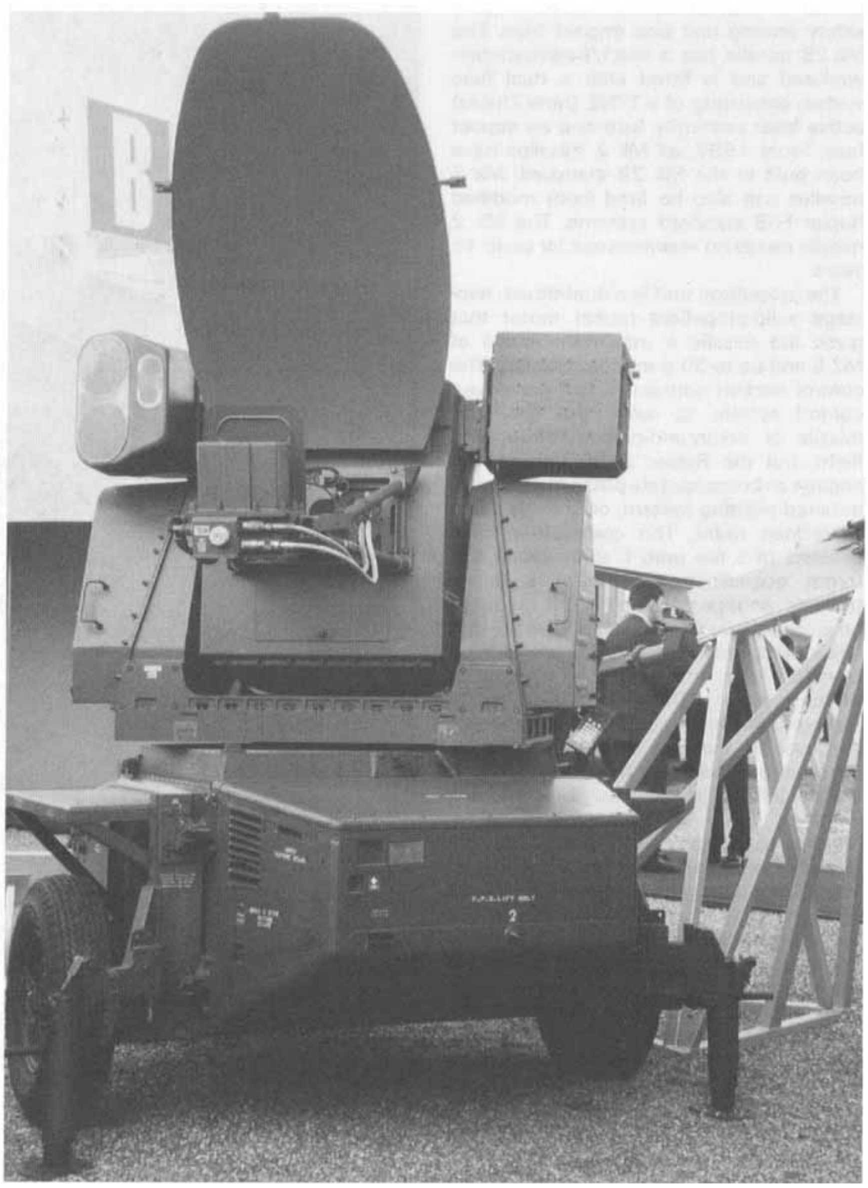
Rapier 2000/Jernas (Field Standard C)

Type

Short-range, ground-based, solid-propellant, theatre defence missile.

Development

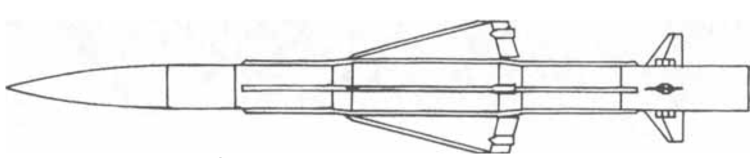
Development of the first Rapier air defence system, the Towed Rapier, began as a private venture in 1961. In 1963 this became a UK government-funded programme ET.316, with the first test firings taking place in 1965. A production contract was issued in 1968, and the system entered service in 1971. These initial basic systems, together with their Blindfire radars, were called Field Standard A. This version has seen combat use in the 1982 Falklands War and, it is believed, with Iran against Iraq during the border skirmishes of the 1970s and the war in the 1980s. From the early 1970s. Rapier was modified several times in order to give greater reliability and to enhance the ECCM and operational capabilities, which brought the system to Field Standard B. This entered service with UK forces in 1982. Other development programmes include Swiss Rapier, Tracked Rapier, Rapier 90, Rapier Laserfire, Rapier Darkfire, Rapier 2000 and Jernas. The first Tracked Rapier entered service in January 1983. Swiss Rapier was a version of Towed Rapier specifically configured to meet the requirements of the Swiss Army, and it was delivered in June 1984. In Rapier 90, the standard optical tracker was replaced by an electro-optical tracker, providing a day/night and poor visibility system. Trials were completed in 1987 and the Rapier 90 system entered service later that year. Development of Rapier Laserfire started in 1983; the purpose of the programme was to produce a low cost automatic system that was not so dependant on operator skills, but was capable of day and night operations. This system completed development, but was not produced. Rapier Darkfire (Electro-optical Rapier) was revealed by British Aerospace (now MBDA Missile Systems) in May 1985 and was a further development of Rapier 90. Rapier Darkfire was delivered to the British Army in 1988, but was not used by the Royal Air Force Regiment, as they decided to wait for Rapier 2000. Iran has developed a Rapier launcher unit mounted on a wheeled 8 × 8 Behr truck, with the system known as Atashbar.



Blindfire 2000 target-tracking engagement radar with a command link antenna (right) and missile gathering unit (left) (Duncan Lennox)

0054272

Development of the Rapier 2000 system (which is also known as Field Standard C or FS C) with the Mk 2 missile started in 1983, as part of the continuing Rapier improvement programme contract for the UK MoD. While the Rapier Field Standard B system was considered to be effective against the current low-level aircraft threat, a major improvement programme was thought necessary if the system was to remain effective beyond the 1990s. The major new areas of threat are expected to include a severe electronic countermeasures environment, multiple pop-up helicopter attacks, anti-radar missiles and smaller battlefield targets such as cruise missiles and UAVs. Jernas (Young Falcon) has been developed from Rapier 2000 specifically for the export market, and includes an air conditioned tactical operations cabin with the Rapier Mk 2 missile and Dagger and Blindfire radars. In 1995 a modified MOWAG Piranha (8 × 8) armoured personnel carrier was offered as an option for the Jernas system. In 1997, it was reported that an improved engagement radar was being developed for the Rapier 2000 system, known as 'Harvester', operating at 94 GHz (Ku-band). A vertical launched Rapier missile system was proposed in 1998. In 2000, a contract was awarded to Raytheon to support the fitting of the Mk XII successor IFF to all UK FSC launcher units.



A line diagram** of **the Rapier** Mk 2 **missile

Description

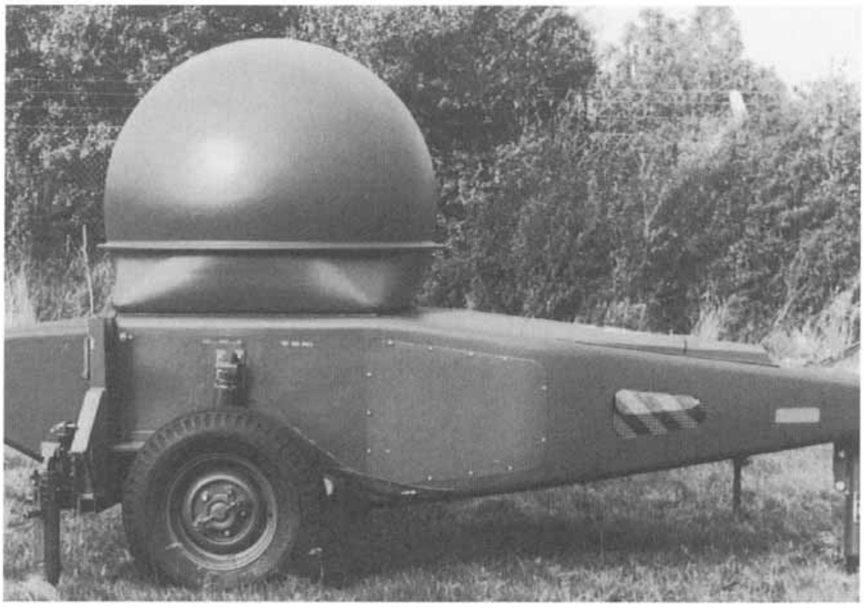
Rapier 2000 (or Rapier FSC) is a mobile, lightweight, air defence missile system designed to destroy attacking low-flying, high-speed aircraft, anti-radar and cruise missiles. The Rapier Mk 2 missile has a slender cylindrical body with a sharp pointed long nose, cruciform clipped delta-wings mid-body with smaller in-line tail control fins. The missile is 2.24 m long, has a body diameter of 0.133 m, weighs 43.0 kg at launch and consists of four main

sections warhead, guidance. propulsion: and control. The Mk 2A missile has a 1.4 kg semi-armour-piercing warhead similar to that of earlier Rapiers with a safetv armina unit and impact fuse. The Mk 2B missile has a blast/fragmentation warhead and is fitted with a dual fuse system consisting of a TTME (now Thales) active laser proximity fuse and an impact fuse From 1999, all Mk 2 missiles have been built to the Mk 2B standard. Mk 2 missiles can also be fired from modified Rapier FSB standard systems. The Mk 2 missile needs no maintenance for up to 15 years.

The propulsion unit is a dual-thrust, two-stage solid-propellant rocket motor that gives the missile a maximum speed of M2.5 and up to 35 g manoeuvrability. The control section contains a hot gas-driven control system to move the fins. The missile is command-guided throughout flight, but the Rapier 2000 system can engage airborne targets passively using an infra-red sighting system, or actively using a tracking radar. The complete system consists of a fire unit, a surveillance and target acquisition radar and a target tracking engagement radar, all mounted on identical two wheel trailers. The fire unit holds eight ready-to-fire Mk 2 missiles on launcher rails, fitted to the sides of a rotating turret. The turret can rotate through 360° in azimuth, from –10 to +60° in elevation and can fire at up to seven missiles per minute. The launcher unit weighs 2,400 kg, has a length of 4.1 m, a width of 2.2 m and a height of 2 6 m. Missiles are reloaded manually and a full reload of eight missiles takes two minutes. The electro-optical tracker, used in passive engagements, is mounted on top of the turret and has been modified to provide improved protection against IRCM. The EO tracker has a range of 15 km. Also mounted on the turret, between the launchers, is the guidance control antenna, which transmits the guidance commands to the missile during flight. The Dagger surveillance and target acquisition radar is supplied by Siemens Plessey (now BAE Systems) and has a planar-array antenna beneath a dome cover. It is a multibeam high resolution 3-D 10 to 12 GHz (X-band) radar that is able to detect up to 75 targets out to ranges of 15 km (49,200 ft) and an altitude of up to 5 km (16,400 ft). Dagger is a frequency-agile radar with pulse Doppler and track-while-scan, it has *two* scan rates, 30 or 60 rpm. Bearing and elevation of all potential targets detected are indicated and classified by IFF Mk 10 or 12. A high-elevation guard beam automatically switches off the radar when an impending attack by an anti-radar missile is detected. The Dagger radar vehicle has a weight of 2,200 kg, a length of 4 1 m, a width of 2 2 m and a height of 2 25 m The engagement radar is supplied by GEC-Marconi (now BAE Systems) and is a re-engineered and modernised version of the Blindfire radar used with Towed Rapier. The Blindfire 2000 radar operates at 3-4 GHz (S-band) and is a differential rnonopulse radar to track both the target and the Rapier missile. This radar has a track-on-jamming mode and a range of 15 km The radar vehicle weighs 2,600 kg. has a length of 4.1 m, a width of 2.2 m and

A mobile Rapier2000 (Jernas)launcher unit firing a Mk 2 missile (Matra BAe Dynamics) 0010189

A towed Rapier 2000 launcher with eight Mk 2 missiles (Peter Humphris) 0085248



A Rapier 2000 'Dagger' surveillance radar vehicle, with 3-D multi-element planar-array and IFF

a height of 2.64 m. The Blindfire 2000 radar has an integral missile command link and an integral EO missile gathering system.

A typical engagement begins when the surveillance radar detects a target from which it does not receive the correct IFF response. A warning is given to the weapon crew and simultaneously the Rapier fire unit and the two trackers slew round to face the approaching target. Target elevation information from the surveillance radar causes the elevation of both the electro-optical tracker and Blindfire engaement radar to be adjusted accordingly. Following acquisition, on the video display the operator sees the system aiming mark superimposed on an infra-red image of the target. The operator now makes a choice: either to use the Blindfire 2000 radar in an active engagement, or to use the EO tracker in a passive engagement. Once locked on, both trackers follow their targets automatically. It is also possible for the system to track two separate targets at the same time, one with the radar and one with the EO tracker. When the target is signalled as being in range the operator presses a firing button to launch a missile, a second missile can be launched within 3 seconds. The maximum missile range is 8 km, with a maximum intercept altitude of 5,000 m.

Operational status

By 2000, around 750 Rapier launchers and 25,000 missiles of all marks had been ordered. Rapier 2000 (or Rapier FSC) and the Mk 2 missile is in production with service trials beginning in 1993; the first units entered operational service with the UK in 1996. Successful firing tests were carried out early in 1991 at the Aberporth range and, by April 1996, over 250 Rapier Mk 2 missiles had been test launched. In 1994 it was reported that the UK had ordered 57 fire units (Rapier 2000 or FS C) and 43 engagement radars (Blindfire 2000). Some in-service Rapier fire units, to Field Standard B, will be modified to be able to launch the improved Rapier Mk 2 missiles. In 1997, discussions were reported with Turkey, concerning a licensed production agreement to build 840 Rapier Mk 2B missiles in Turkey, as a follow-on to the upgrade of the Turkish 86 Rapier Field Standard B launchers. This was confirmed in 1999, with two production lines to be set-up in Turkey and the UK to build 840 missiles for Turkey and 1,680 missiles for the UK. Some components will be made in Turkey and used on both production lines, and it is expected that deliveries will be phased over 10 years starting in 2002. The UK will also upgrade some earlier missiles to the Mk 2B standard. Singapore flight tested a Rapier Mk 2 missile at Woomera in Australia in April 1999, as part of an upgrade of their Rapier systems to the B1(X) or Rapier 2 standard. Oman and Switzerland are also reported to be upgrading their missiles to the Mk 2 standard. Proposals were made in 2001 for Switzerland to build Mk 2 missiles, and for Indonesia to purchase 400 missiles.

Specifications

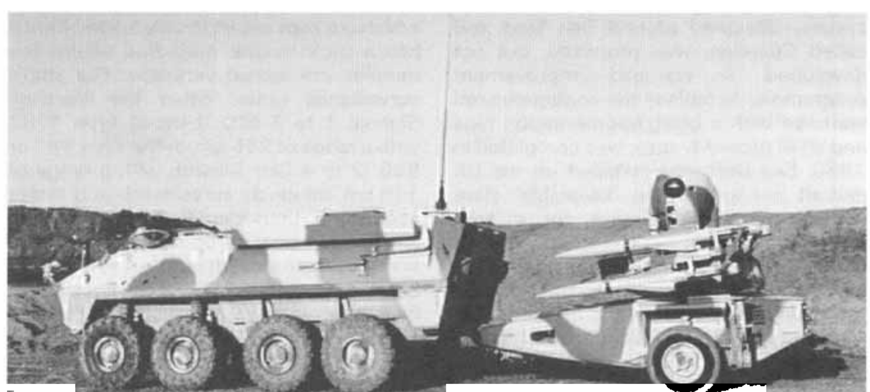
Rapier **2000** Mk 2
Length: 2.24 m
Body diameter: 0.133 m
Launch weight: 43.0 kg
Warhead: Mk 2A 14 kg HE semi-armour-piercing; Mk 2B 1.4 kg blast/fragmentation
Guidance: CLOS
Propulsion: Solid propellant
Range: 8 km

Associated radars
Surveillance radar: 3-D Dagger
Frequency: 10-12 GHz (X-band)
Peak power: n/k
Range: 15 km

Engagement radar: Blindfire 2000
Frequency: 3-4 GHz (S-band)
Peak power: n/k
Range: 15 km

Contractor

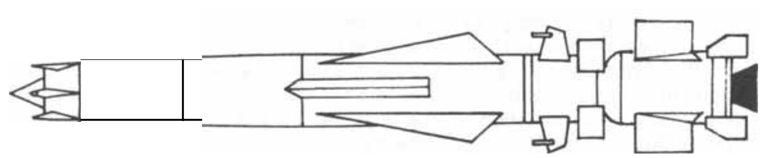
MBDA Missile Systems, Stevenage.



A Rapier 2000/Jernas launcher being towed by a MOWAG Piranha vehicle that also acts as the Tactical Operating Centre (Matra BAe Dynamics) 0010190

Sea Dart (GWS 30)

HMS Manchester, *a Type 42 destroyer, with two Sea Dart missiles on the launcher forward of the bridge and an engagement Type 909 radar in a cupola above and behind the bridge*



***A** line diagram of **the Sea** Dart missile*

Type

Short-range, ship-based, ramjet-propelled, theatre defence missile.

Development

Sea Dart (GWS 30) was developed as a third-generation area defence surface-to-air weapon system, with a secondary surface-to-surface anti-ship role. Development started in August 1962 as CF 299, part of a UK/Netherlands project using the Broomstick radar and designed for the Type 42 destroyer. Test firings began in 1965 and the first production order was announced in November 1967. The system finally entered service with the commissioning of the destroyer HMS *Bristol* in March 1973 and the missile has been steadily upgraded since then. The Sea Dart system uses a Siemens Plessey (now BAE Systems) Type 992 or Type 996 surveillance radar. The Type 909 target tracking and illuminating (engagement) radar produced by GEC-Marconi (later Marconi Electronic Systems and now BAE Systems) was developed from the equipment used with earlier Bloodhound and Thunderbird land-based surface-to-air missile systems. Plans to improve the Sea Dart system with improved electronics, new fuse and two channel trackers were made in the late 1970s and it was planned to introduce them for the mid-life updates of the Type 42 destroyers. However, this programme was abandoned in 1981 for financial reasons. In 1978 British Aerospace (now MBDA Missile Systems) announced and offered a lightweight version of the Sea Dart system, intended for ships down to 300 tonnes in size. Demonstration firings were conducted in 1981 but the project has lapsed. In June 1982 a long-range land-based air defence system, designed around Sea Dart and called Guardian, was proposed, but not developed. A warhead improvement programme, to replace the continuous rod warhead with a blast/fragmentation type and an IR proximity fuse, was completed in 1989. Sea Dart was installed on the UK aircraft carriers of the 'Invincible' class (CVSG), with 36 missiles for a twin launcher system; and on Type 42 destroyers, with 22 missiles each for a twin launcher system. However, the missiles were removed from the aircraft carriers in 1999. In addition, Sea Dart is fitted to two 'Hercules' (ex-Type 42) destroyers of the Argentine Navy, with 22 missiles in each ship.

Description

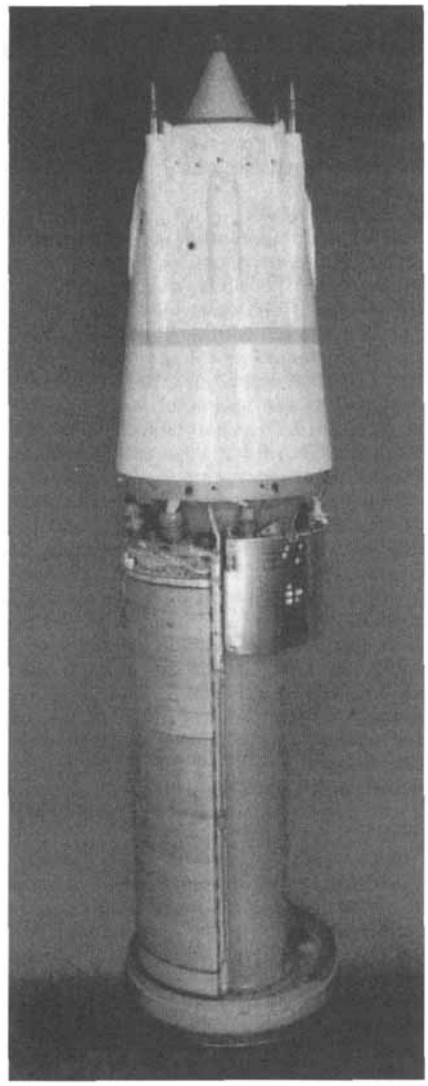
Sea Dart has a cylindrical body with a tandem booster motor aft. The missile has an annular ramjet intake at the nose, with a radome in the centre and four antennas around the intake. The missile has four long-chord delta-wings aft of the mid-body and four small in-line moving control fins at the rear. The solid-propellant Chow boost motor assembly has four large rectangular stabilising fins at the rear end. The missile is 4.36 m long, has a body diameter of 0.42 m and weighs 550 kg. The Sea Dart is mounted on deck, on twin launchers, which are kept automatically loaded from a below-deck missile magazine where the missiles are stored vertically. The ship's surveillance radar, either the Marconi-Signaal 1 to 2 GHz (L-band) Type 1002 with a range of 265 km, or the Type 992 or 996 (2 to 4 GHz S-band) with a range of 115 km, conducts surveillance and target acquisition, then identified hostile targets are handed over to one of the two Type 909 engagement radars. The 4 to 8 GHz (C-band) engagement radars are believed to have a range of 70 km against high-flying aircraft targets. The engagement radar automatically tracks the targets and trains the launchers. The target co-ordinates are passed to the missile's guidance system and once the designated target is in range, the missile is launched. The engagement radar continues to illuminate the target for the missile, which uses inertial guidance and semi-active radar homing throughout its flight.

Once launched the Chow Mk 52 solid-propellant booster accelerates the missile to M2.0 plus before it is jettisoned. At this speed, the Odin ramjet sustainer motor is lit and the speed is built up and sustained at about M2.5. out to a maximum range of 40 km. The missile has an effective altitude intercept band of between 100 m and 18.5 km. The HE continuous rod warhead is detonated by an impact fuze or by an active radar proximity fuze, but the later modification blast/fragmentation warhead has an IR proximity fuze. The fire-control computer advises the operator when interception is imminent and he can select another target. With the Type 996 three-dimensional surveillance radar, transfer of data from the surveillance radar to the engagement radar has been automated to increase the speed of the overall system. When used in its secondary role as an anti-ship missile, Sea Dart follows an up-and-over trajectory, climbing steeply after launch and descending equally steeply on to the target. The kinetic energy built up by the missile on its downward path ensures that the missile penetrates the armoured decks of the target ship.

Operational status

Sea Dart entered service in 1973 and it is estimated that over 1,000 missiles have been produced and are in service with Argentina and the UK. Argentina is believed to have some 60 weapons for use aboard two 'Hercules' (Type 42) destroyers. In May 1982 Sea Dart was used operationally during the Falklands conflict. It was used again in the 1990-91 Gulf War, when an Iraqi coastal defence

A Sea Dart twin launcher on a Type 42 destroyer (van Ginderen) 0054273



A Sea Dart seeker and radome assembly

CSS-N-2 'Silkworm' missile was successfully intercepted. A mid-life refurbishment and improvement programme, to extend the life of the whole Sea Dart system on the Type 42 destroyers to around 2015, was contracted in 1996. In 1997, the UK announced plans to remove Sea Dart missiles and launchers, but not the radars, from the three 'Invincible' class support carriers, and this was completed in 1999.

Specifications

Length: 4.36 m
Body diameter: 0.42 m
Launch weight: 550 kg
Warhead: HE blast/fragmentation/ continuous rod
Guidance: Inertial with semi-active radar
Propulsion: Ramjet with solid booster
Range: 40 km

Associated radars
Surveillance radar: RN Type 1022
Frequency: 1-2 GHz (L-band)
Peak power: n/k
Range: 265 km

RN Type 996
Frequency: 2-4 GHz (S-band)
Peak power: n/k
Range: 115 km

Engagement Radar: RN Type 909
Frequency: 4-8 GHz (C-band)
Peak power: n/k
Range: 70 km

Contractor

MBDA Missile Systems, Stevenage.

Seawolf (GWS 25/26)

Type

Short-range, ship-based, solid-propellant, theatre defence missile.

Development

The original requirement for a ship-based anti-missile system was written by the UK MoD in 1964. Feasibility studies, under the codename Confessor, led to British Aerospace (now MBDA Missile Systems) being nominated as missile contractor in 1967, GEC-Marconi (now Alenia Marconi Systems) as the contractor for the overall ship system with its associated radars, and Vickers (VSEL) for the launching system. Project definition commenced in 1967 and the full development programme started in 1968. After successful trials in 1969 the new missile system was officially known as Seawolf/GWS 25. The first Seawolf missiles (GWS 25 Mod 0) entered service in 1973. In June 1977, a 4.5 in (0.114 m) shell was hit by a Seawolf missile and in 1983 an MM 38 Exocet missile was intercepted. In the late 1980s. a lighter weight all-radar tracker was introduced onto some Type 22 frigates, employing the dual-frequency Type 911 radar and deleting the TV tracker. This system retains the six-barrel missile launcher and is known as GWS 25 Mod 3.

A vertical launch Seawolf missile, incorporating a tandem thrust vector control boost motor, which also gave an increased intercept range, was developed with government funding. Despite a Royal Navy decision late in 1967 not to proceed with this variant (due to its added complexity), six successful firings of the test vehicle, known as Sinner, took place in 1969.

During the 1980s the vertically launched Seawolf system was revived, developed further and designated GWS 26 Mod 1. The first production version of this latest missile was handed over to the RN in early 1989. A further version of the Seawolf system, using new lightweight launchers and the Type 911 lightweight radar, was also developed in the late 1980s for retrofitting to the RN aircraft carriers and the Type 42 Batch 3 destroyers. The Lightweight Seawolf system was designated GWS 26 Mod 2. However, in July 1991 the UK Seawolf GWS 26 Mod 2 development and production contract was cancelled, together with the lightweight Type 911 radar. A development and initial production contract was placed in 1996 for an upgraded Mk 4 fuze assembly for the Seawolf missile, and deliveries started in 2001. The UK MoD led a project definition study for a Seawolf Mid-Life Update (SWMLU) programme in 1996, with development and initial production contracts placed in February and May 2000. This SWMLU is planned for both GWS 25 Mod 3 and GWS 26 Mod 1 systems. It will include a replacement X-band engagement radar, the addition of an EO tracker for the target and missile, improved tracking algorithms for the engagement radars and EO tracker, and revised system software. Development of a common missile started in 1996, so that

A trials launch of a Seawolf VLS (GWS 26 Mod 1) missile from a launch silo on a type 23 frigate (Matra BAe Dynamics) 0054274

A Seawolf (GWS 25 Mod 0) surface-to-air missile (Royal Navy)

the front end 'dart' of both the GWS 25 Mod 3 and GWS 26 Mod 1 missiles would be the same; this version has been called Block 2. MBDA is developing a cold launch version for the GWS 26 Mod 1 missile, using compressed gas to eject the missile from its canister. The missile will then be turned over by a small motor pack, followed by boost motor ignition. Some 20 tests were made in 1998 using inert missiles, and live missile tests started in 1999.

Studies on a third version of the Seawolf missile, called Wolverine, started in 1988 and continued until 1993. This was basically to be a modified VLS Seawolf giving improved performance for defence against tactical ballistic missiles, but this project was not continued.

GWS 25 Mod 0 and Mod 3 Seawolf missiles are fitted to UK Type 22 'Broadsword' class frigates, with two sextuple deck-mounted launchers and 32 missiles per ship. Four ex-'Broadsword' class frigates have been sold to Brazil, with Seawolf missiles. GWS 26 Mod 1 VLS Seawolf missiles are fitted in deck-mounted silos on UK Type 23 'Duke' class frigates with 32 missiles each. Plans for Seawolf to be fitted to the new auxiliary oiler replenishment vessels of the Royal Fleet Auxiliary were cancelled in 1994. GWS 26 Mod 1 VLS Seawolf missiles are being fitted to two new 'Lekiu' class frigates for Malaysia, with 16 missile canisters, and VLS Seawolf missiles will be fitted to three new corvettes to be built for Brunei with 16 missile canisters and carrying 32 missiles each.

Description

Seawolf is a small lightweight missile with four fixed delta-wings on the centrebody and four rear-mounted moving delta control fins. The GWS 25 missile is 2.0 m long, has a body diameter of 0.18 m and, with a 14 kg HE fragmentation warhead, weighs 82 kg at launch. Guidance is by Command to Line Of Sight, (CLOS) with target and missile tracking by radar or TV systems. Command-guidance is transmitted to the missile, which has four receiver aerials (one on the rear of each wing assembly). The missile has a solid-propellant boost/sustainer motor, called 'Blackcap', which accelerates it to a maximum speed of M2.0. GWS 25 has a maximum range of 6 km.

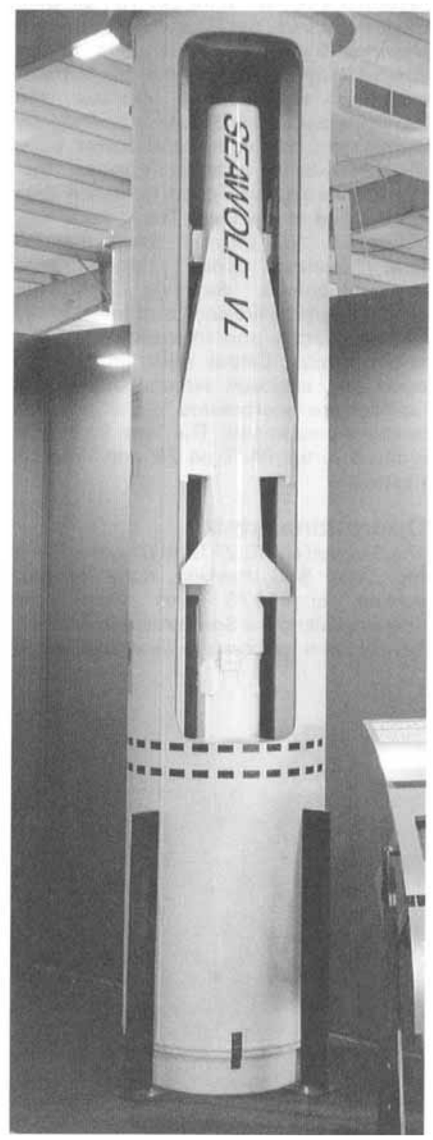
The Seawolf GWS 25 Mod 0 system has a six-barrel deck-mounted launcher, trainable in azimuth and elevation, and a Type 910 engagement radar. The system also includes a TV camera, mounted on and aligned with the engagement radar's antenna. Controlled manually from the weapon console, the TV camera is used to track and establish a line of sight to targets approaching at very low level where multipath returns degrade the tracking accuracy of the Type 910 radar.

The Seawolf GWS 25 Mod 3 is similar to the Mod 0 system, but incorporates the Type 911 dual-frequency lightweight engagement radar. Designed to counteract the threat posed by anti-ship missiles, the Type 911 radar obviates the need for the TV camera and all engagements are carried out automatically under radar direction.

The VLS Seawolf GWS 26 Mod 1 uses the Type 911 radar and a modified Seawolf GWS 25 missile, with the addition of a turnover pack incorporating a 'Cadiz' tandem booster motor with thrust vector control. The tandem boost motor increases the length to 3.3 m and the launch weight to 140 kg. The boost motor section is jettisoned once the missile has levelled out and is on its way to the target. The second stage or missile dart is similar to the GWS 25 missile, but has a Mk 3 RF fuze, which uses a pulsed magnetron, and a separate impact fuze. A Thales Mk 4 dual-mode active radar/laser fuze, with improved low-level performance and known as the Seawolf Enhanced Low Level (SWELL) fuze, was introduced from 2001. VLS Seawolf missiles are stored, transported and handled in sealed launch canisters. These canisters are mounted vertically either singly, in clusters, or in silos, above or below decks, or containerised. This enables installations to be configured in a variety of ways and optimised for any type of ship. GWS 26 Mod 1 missiles have a maximum range of 7 km. With the introduction of the Block 2 missiles, the second-stage 'dart' will be the same for both the GWS 25 and 26 missiles.

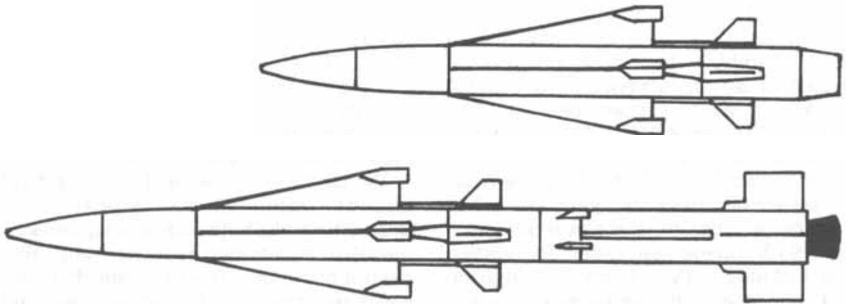
The Lightweight Seawolf GWS 26 Mod 2 used the same Type 911 radar and basic Seawolf missile, but had a new lightweight trainable four-barrel launcher and fire-control computer. The new launcher was developed from the Seacat launcher and used the same pedestal. An alternative to the Type 911 engagement radar is the GEC-Marconi (now Alenia Marconi Systems) 1802SW radar, which has been selected by Malaysia.

After launch, the Seawolf missile is acquired by the Type 910 wide-angle antenna and automatically gathered onto the target line of sight. Subsequently, targets and missiles are tracked together, using the same antenna and receiver by means of time division multiplex techniques. The Seawolf system uses CLOS-guidance with radar differential tracking and a microwave radio-command

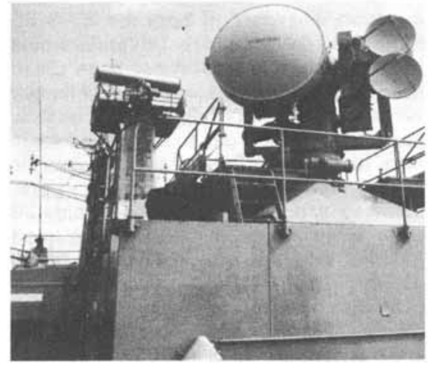


A GWS 26 vertical-launch Seawolf missile in a cutaway canister (Duncan Lennox)
0010188

RN Type 911 engagement radar



Line diaarams of the GWS 25 Seawolf missile (top), and the larger VLS Seawolf (GWS 26 Mod 1) missile (bottom) 0054275



RN Type 910 engagement radar system with Type 967/968 antenna in the background

link. The system is capable of controlling and directing a number of Seawolf missiles to interception. The Type 910 radar is fitted to Brazilian ships.

The RN Type 911 radar is a dual-frequency (X/K-band) differential tracking engagement radar, which includes a command link to control the Seawolf missile in flight. The X-band antenna and transmitter are used for targets attacking from high angles. The K-band part of the system is a version of the DN 181 Blindfire radar used with the Rapier missile and it provides tracking at low sight angles against targets close to the sea surface, such as sea-skimming missiles and low-flying aircraft. A system independently illuminating the upper and lower parts of the K-band antenna ensures that the missile receives good guidance data while flying at low level. The radar is fully automatic to provide fast reaction time against small targets and is autonomous, requiring only the allocation of the fire-control channel to the selected target and information on the ship's motion. Clutter rejection (in both open and enclosed waters) and ECCM facilities are incorporated to enable use in hostile environments. The Type 911 radar is fitted to the RN Type 22 and Type 23 frigates.

Operational status

The Seawolf (GWS 25 Mod 0) system with the Type 910 tracking radar entered service in 1973 and was used operationally in the South Atlantic in 1982, having been successfully demonstrated in use against aircraft and sea-skimming missiles. The Seawolf with the Type 911 tracking radar entered service in 1989. The first firing of a VLS Seawolf GWS 26 Mod 1 missile took place in 1990, and the system entered service in 1991 with an order for 11 ship sets. This order included 950 missiles, 18 tracking radars (Type 911) and 15 launcher assemblies. A further order for Seawolf Block 2 missiles, using the common 'dart' and Mk 4 fuze for both GWS 25 and 26 systems, was placed by the UK MoD in February 2000, for delivery from 2004. The shipborne equipment will be upgraded by a team led by Alenia Marconi Systems, who received an 11-year contract in May 2000, for delivery from 2006 in 21 ship sets. The Seawolf system has been exported to Brazil and Malaysia, and ordered by Brunei.

Specifications

GWS 25
Length: 2.0 m
Body diameter: 0.18 m
Launch weight: 82 kg
Warhead: 14 kg HE fragmentation
Guidance: CLOS
Propulsion: Solid propellant
Range: 6 km

GWS 26 Mod 1
Length: 3.3 m
Body diameter: 0.18 m
Launch weight: 140 kg
Warhead: 14 kg HE fragmentation
Guidance: CLOS
Propulsion: Solid propellant
Range: 7 km

Associated radars
Surveillance radars: RN Types 967 and 968
Frequency: 1-3 GHz (L-band)
Peak power: n/k
Range: n/k

RN Type 996 (3-D radar)
Frequency: 2-4 GHz (S-band)
Peak power: n/k
Range: 115 km

Engagement radars: RN Type 910
Frequency: 8-12 GHz (X-band)
Range: n/k

RN Type 911 (805SW)
Frequency: 8-10 GHz (X-band) and 20-40 GHz (K-band)
Peak power: n/k
Range: n/k

1802SW
Frequency: 8-10 GHz (X-band) and 20-40 GHz (K-band)
Peak power: 50 kW peak
Range: 40 km

Contractors

Alenia Marconi Systems. Radar Systems Division, Chelmsford.
MBDA Missile Systems, Stevenage.

ASM-135 Anti-Satellite System

Type
Air-launched, anti-satellite weapon.

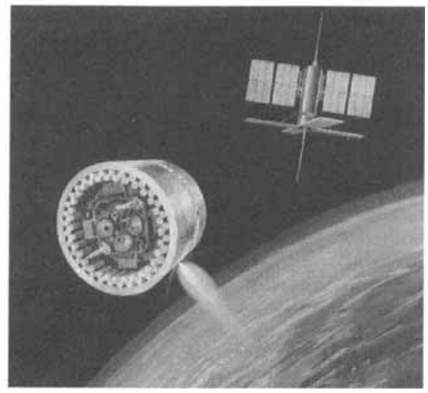
Development
The original US Anti-Satellite (ASAT) development programme was called Bold Orion, which comprised an air-launched missile. This was followed by two ground-based, direct ascent systems based on the Nike-Zeus and Thor missiles. The Thor system was sufficiently successful for it to be deployed and maintained on Johnson Island in the Pacific, becoming operational in 1964.

Development of a second air-launched ASAT weapon began in 1970, with USAF research on a prototype miniature air-launched system. The Vought Corporation, now Lockheed Martin, began the ASAT development in 1980. The initial F-106 carrier aircraft was replaced by the F-15 in 1983, and the first launch from an F-15 took place in 1984. A part of the specification for the system was that the F-15 carrier aircraft was required to be prepared for an ASAT mission from the standard line configuration in under 6 hours. Tests of the infra-red guidance system in the ASAT took place in November 1984, using a star to evaluate the booster, booster guidance system and miniature vehicle flight sensor. A successful test against a satellite in orbit took place in September 1985. The programme was terminated in 1988 in favour of a ground-launched direct ascent system, now being re-examined by the US DoD.

Description
The ASM-135 system resembled a conventional tactical missile, with a length of 5.18 m and a diameter of 0.51 m. The launch weight was 1,180 kg. The ASAT was carried in the direction of the target as a missile, comprising a modified Boeing AGM-69 SRAM first-stage and an Altair III second-stage. The ASAT weapon itself, the Miniature Homing Vehicle (MHV), was approximately 40 cm long, 30 cm in diameter and weighed about 60 kg. The kill mechanism was provided by the kinetic energy of the homing vehicle itself; no additional warhead was provided. The MHV was spin-stabilised, had no axial motor and used a ring of peripheral rockets to adjust its trajectory according to instructions from the infra-red sensor and onboard computer.

Guidance for the pre-launch phase was provided by the F-15 system, with cues to the pilot being provided via the head-up display.

Operational status
The USAF estimated a need for 112 ASAT vehicles and a total of US$1.8 billion was spent on research and development. However, the programme was held in the research and development stage by Congress, who declined to allow further tests in the hope of achieving an ASAT ban with the former Soviet Union. This caused delays and eventually led to cancellation of the project, in favour of a ground-launched version. It is believed that a small number of ASM-135 missiles remain available for operational use in an emergency.



An artists concept of the ASAT miniature homing vehicle approaching a satellite target

Specifications
Length: 5.18 m
Diameter: 0.51 m
Launch weight: 1,180 kg
Warhead: Miniature homing vehicle 60 kg
Guidance: Ground command via F-15 prior to launch then inertial and IR terminal
Propulsion: Two-stage solid
Range: 800 km

Contractors
Lockheed Martin Missile and Fire Control Systems, Dallas, Texas.
Boeing Space and Communications Group, Seal Beach, California.

An F-15 carrying the ASM-135 ASAT missile

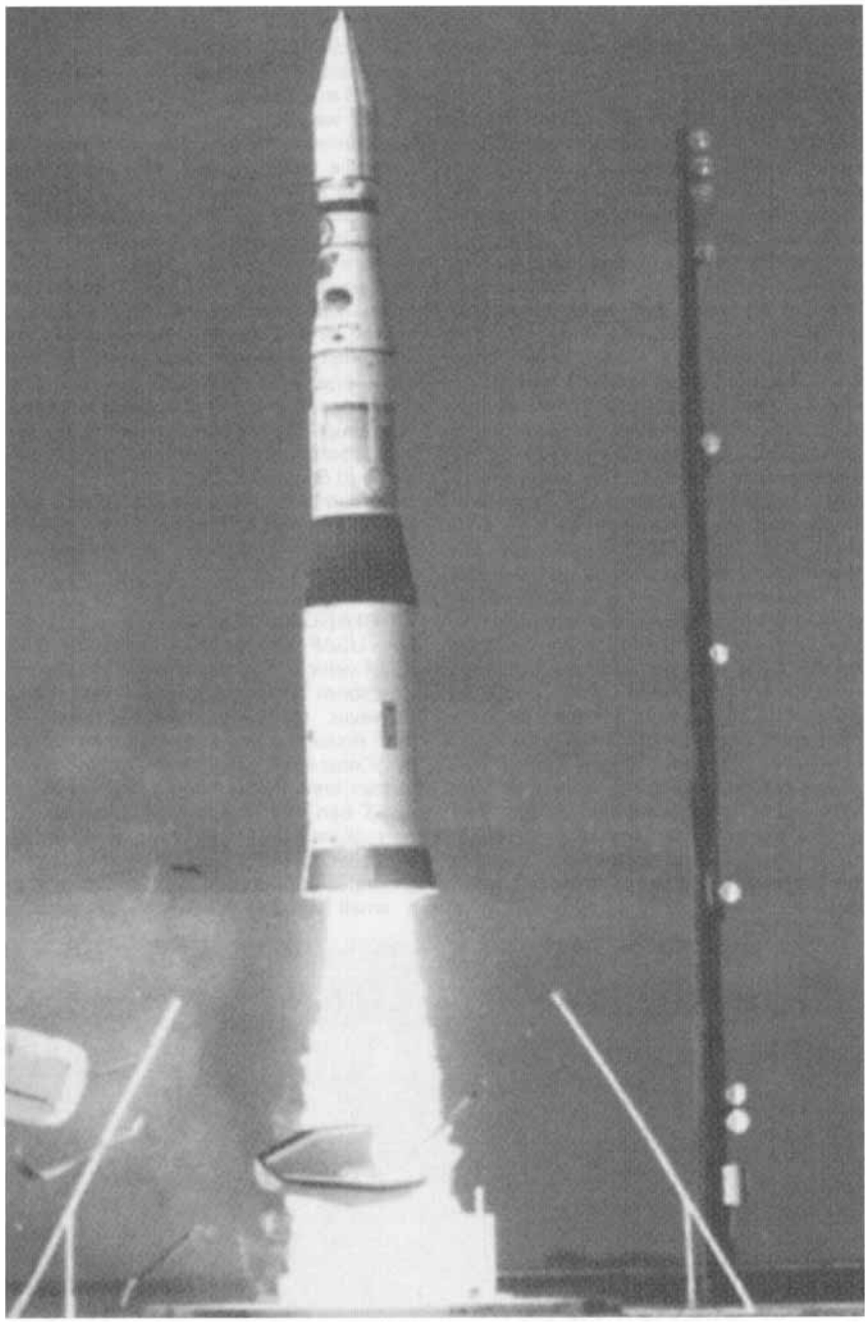
Ground-based Mid-course Defense (GMD) Segment

Type
Long-range, silo-based, solid-propellant, anti-ballistic missile.

Development
In 1984 the US Army conducted the homing overlay experiments, which demonstrated a successful intercept of a re-entry vehicle by a long-range ground-launched surface-to-air missile. This was followed in 1990 by the High Endoatmospheric Defense Interceptor (HEDI) programme, which tested IR seekers at high velocity in the upper atmosphere to determine how heating effects would affect their performance. The effects were less than expected, and in 1991 an Exoatmospheric Re-entry vehicle Interception Systems (ERIS) flight demonstrated a successful intercept at 925 km range and at an altitude of 270 km. A second ERIS flight in 1992 missed the target RV by around 6 m. A Ground Based Interceptor (GBI) programme started in 1992, was halted in 1993, and re-started again in 1995. Originally intended to provide an anti-ballistic missile defence of the whole of the USA from several sites located around the coastline, the first design had a range of around 2,000 km. The provisions of the 1972 ABM Treaty limited the Russian Federation and the USA to just one interceptor site and 100 missiles, and in 1995 the GBI range requirement was increased to 2,500 km so that only one launch site would be used.

Following the halting of the GBI programme in 1993, an Exoatmospheric Kill Vehicle (EKV) research project was funded, to continue with the design work that had been started earlier to look at a possible hit-to-kill vehicle for use against incoming threat warheads. Two flight tests were made in 1997 and 1998 with competing EKV designs, by Rockwell (now Boeing) and Hughes (now Raytheon), and in November 1998 the Raytheon design was selected.

Boeing were appointed the lead systems integrator for the US National Missile Defense (NMD) programme in April 1998, and started to integrate the GBI missile with sensors and a command and control system. The initial flight-test programme used LGM-30F Minuteman II second- and third-stage solid-propellant motors as the boost vehicle for GBI, but in 1998 commercial motors were selected for the operational missile version. The GBI planned flight-test programme had 21 launches up to 2005, with the first fully representative operational missile being tested on the 13th flight. A Ground Based Radar-Prototype (GBR-P) was located at Kwajalein Atoll in the south Pacific in 1998, and has been used for test flights by various target missiles to examine the discrimination of closely spaced threat objects, to identify the warhead from amongst debris or countermeasures. The GBR-P is based upon the mobile THAAD ground-based radar, but for production it is planned to develop a more powerful and longer range version to be known as XBR.



An early test launch of a GBI (now GMD) prototype (US Army) *2001*/0062339

This X-band radar will be used to provide target discrimination, threat object map updates to the EKV, and kill assessment after an intercept.

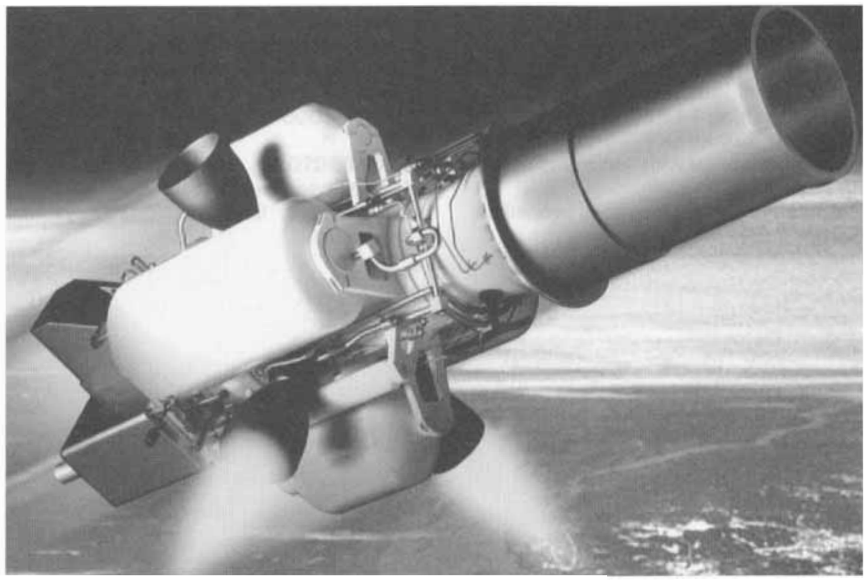
In 2001 the GBI programme name was changed to the Ground-based Mid-course Defense (GMD) segment, and in December 2001 the USA gave notice that it would leave the ABM Treaty. This provided the opportunity to re-assess the programme, and several changes have been made. An alternative boost vehicle, to be developed by Orbital Sciences, was selected using variants of commercial boost motors for the three stages. It is planned that the maximum velocity of the GMD will be increased to between 7 and 8 km/sec, and the range may also be increased. A joint EKV programme has been proposed combining the technologies from the GBI and SM-3 programmes, and an alternative EKV design has been discussed. The Cobra Dane radar on Shemya Island in the Aleutian Islands will be upgraded together with the Pave Paws early warning UHF radar at Beale AFB, Marysville, California. Five GMD launch silos will be built at Fort Greely in Alaska, and two silos at Kodiak Island in Alaska.

Description
The size and shape of the operational GMD interceptor are not known, but the following are estimates based on the flight test vehicles. The three-stage solid-propellant missile has an overall length of

17.5 m, a body diameter for the first stage of 1.01 m, for the second stage of 0.8 m, and for the third stage of 0.7 m. The launch weight is 14,820 kg. The first stage length is 13.0 m, and weight is 13,300 kg. The second and third stage lengths are 1.5 m for each stage, with a weight of 700 kg for each. The EKV has a length of 1.5 m, a diameter of 0.8 m, and a weight of 120 kg at launch, including the shrouds and separation mechanism. The first stage will use an Alliant Techsystems GEM-40VN solid-propellant motor, originally developed as one of the strap-on boost motors for the Delta 2 satellite launch vehicle. This motor has a vectoring nozzle, weighs 13,232 kg, contains 11,765 kg of propellant and burns for around 63 seconds. The first stage has a solid propellant attitude control system developed by Aerojet. The second and third stages will use United Technologies (Pratt and Whitney Chemical Systems Division) Orbus 1A motors. These motors have vectoring nozzles, weigh 470 kg, contain 417 kg of HTPB solid propellant and burn for 40 seconds each. The motor bodies are made from graphite epoxy. The booster motor assemblies burn for about 145 seconds, and then the EKV protective shrouds are jettisoned and the section separates. The minimum range for GMD is estimated to be 1,000 km, and the maximum range 2,500 km.

Following separation from the third-stage motor assembly, the EKV takes some visual star sightings to align its inertial measurement unit and seekers, and then receives command updates from the ground-based engagement radar. The command updates are sent using the In-Flight Interceptor Communication System (IFICS). The EKV has dual-band CMT 256 × 256 focal plane arrays operating in the IR medium waveband, and a visual band TV seeker. The imaging IR detector arrays are cryogenically cooled using krypton gas. A telescope is mounted in front of these seekers, and the target is acquired at 600 to 800 km distance. The EKV closes with the target at between 7 and 10 km/s, and has around 5 seconds to manoeuvre to achieve a hit on the incoming warhead. Shortly before the terminal phase, the ground-based radar transmits a target object map up to the EKV, designating the target warhead from amongst the debris and countermeasures objects. A liquid monomethyl hydrazine bipropellant motor system enables the EKV to divert towards the target, with a cold helium gas attitude control system. The EKV has no warhead as such, and relies on kinetic energy at impact to destroy the target. The EKV weight is believed to be around 50 kg at impact.

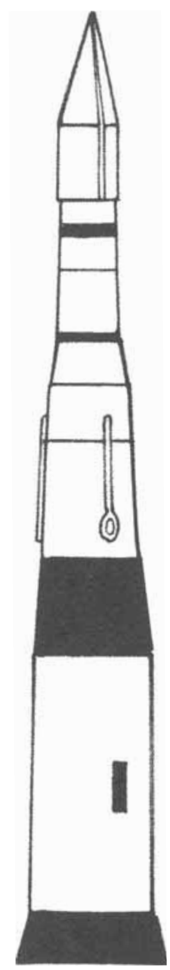
The complete missile will be transported and located within its launch silo inside a canister, with a hot launch from the canister using the first stage motor. The canister has been designed by a team led by Northrop Grumman. Early warning of a possible threat ballistic missile launch will be provided by the US Defense Support Programme (DSP) satellites, located in geosynchronous orbits and covering the majority of the earth. These are planned to be replaced by around 2005 by SBIRS high satellites. The missiles will then be tracked by UHF radars, either BMEWS or Pave Paws radars, located in the USA and at Thule and Fylingdales. As the threat missiles approach the US, they will be acquired and tracked by the engagement radar, which will then update the EKV so that it can acquire and track the designated warhead. The GBR-P is an X-band surveillance and engagement radar (8 to 10 GHz), designed by Raytheon and based upon the THAAD GBR design. The development GBR-P being used in the early trials has 16,896 transmit and receive modules. The operational XBR will use 78,848 transmit and receive modules, and will have a range of 4,000 km. The XBR will have mechanical rotation of ±178° in azimuth and electronic coverage of 0 to 90° in elevation. The electronic field of view will be 50 × 50°.



An artists impression of an EKV in flight (Raytheon) **2001**0105779

Operational status

The GBR prototype has been located at Kwajalein Atoll in the Marshall Islands on the south Pacific test range since 1998, with several test launches of ICBM and suites of test targets being made each year. A test flight in September 2000 had 35 objects within the test suite, to examine the discrimination capabilities of the radar software. A flight test programme for the GMD and EKV plans for 25 flight tests up to 2006. IFT-1 and IFT-2 were the competing sensor design tests flown in 1997 and 1998. IFT-3 was flown in October 1999 and resulted in a direct hit. IFT-4 was flown in January 2000 and resulted in a miss due to a failure of the IR detectors cooling system. IFT-5 was flown in July 2000, and failed as the EKV did not separate from the third stage. IFT-6 was flown in July 2001 and IFT-7 in December 2001, and both were successful intercepts of a warhead with one decoy balloon. Both intercepts were made at an altitude of 225 km and at a range of 700 km from the interceptor launch. IFT-8 was flown in March 2002 against a warhead and three decoy balloons, and was successful with an intercept at an altitude of 175 km. The first operational build standard flight test is planned for IFT-13, expected in 2004.



A line diagram of an operational GMD
2001/0105778

The operational system has not been decided, and test facilities are being built at Fort Greely and Kodiak Island in Alaska. Plans indicate that up to 70 interceptors might be built by 2008, and these will be used to complete the development flight tests and to provide an initial operational capability.

Specifications

Length: 17.5 m
Body diameter: 1.0 1 m (1st stage), 0.8 m (2nd). 0.7 m (3rd). 0.8 m (EKV)
Launch weight: 14,820 kg
Warhead: 120 kg EKV
Guidance: Inertial with command updates, IIR and visual.
Propulsion: Three-stage solid propellant
Range: 2,500 km

Associated radar
Engagement radar: Raytheon XBR
Frequency: 8 to 10 GHz (X-band)
Peak Power: n/k
Range: 4,000 km

Contractors

Boeing Space and Communications Group, Seal Beach, California (lead systems integrator).
Raytheon Air and Missile Defense Systems, Bedford, Massachusetts (XBR).
Raytheon Missile Systems, Tucson, Arizona (EKV).

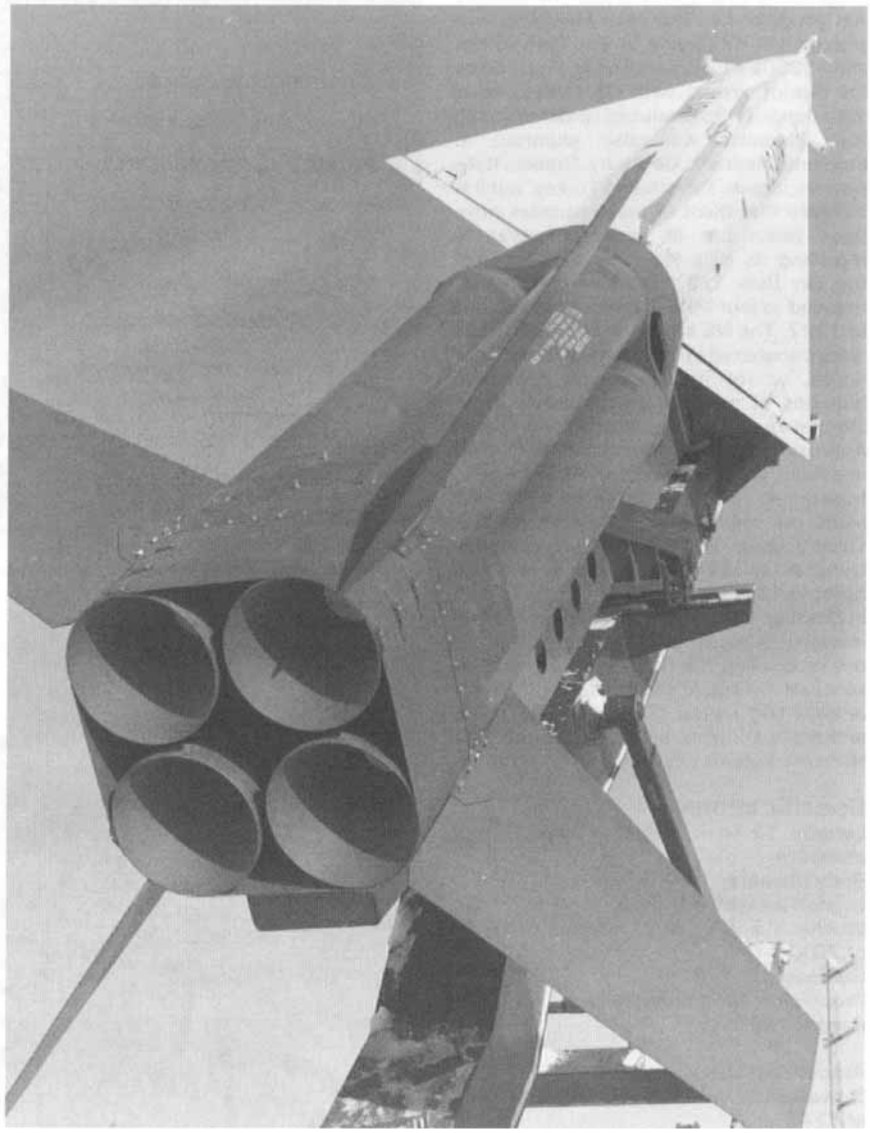
MIM-I 4 Nike Hercules

Type

Medium-range, ground-based, solid-propellant, theatre defence missile.

Development

The MIM-14 Nike Hercules was developed as a nuclear warhead surface-to-air missile, as the replacement for the older Nike Ajax (MIM-3). which was range limited and only had an HE warhead. Development commenced in 1954 with the prime contractors being Western Electric Company (now AT&T Technologies) and McDonnell Douglas (now Boeing). Delivery of the first production rounds to the US Army was made in January 1958 and the system became fully operational later that year. During trials, the missile successfully intercepted short-range ballistic missiles such as Corporal, and simulated missiles including other Nike Hercules missiles. Delivery to the US forces was completed in March 1964, but production for export to a number of NATO countries continued after this date, and a non-nuclear version was produced under licence for the Japanese Air Defence Force by Mitsubishi Heavy Industries. The missile system was also developed for use in the surface-to-surface role with a contact fused nuclear warhead. Three different models of missile were produced: the MIM-14A, MIM-14B and the MIM-14C. Major improvements were made to the system in 1961, when new radars and modifications were added to enable the system to remain operational until replaced by the Patriot (starting in 1984). South Korea modified a version of the Nike Hercules with an HE warhead, for the surface-to-surface role, and flight tests were made in 1978 up to ranges of 250 km. These were later limited to 180 km following a formal agreement with the USA, but this agreement was concluded in 2001 when South Korea joined the MTCR. In 1981 contracts were placed for a number of improvement programmes to the existing Nike Hercules systems. These included replacing the earlier analogue system with a digital computer and, as a result, reliability of the Nike Hercules system was improved and maintenance simplified.

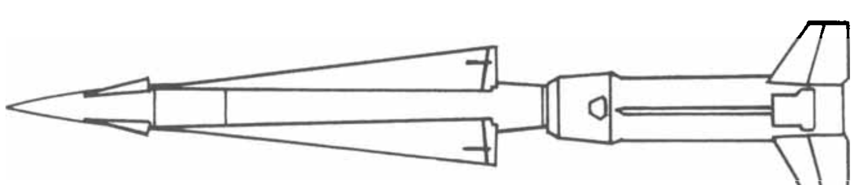


A rear end view of the MIM-14 Nike Hercules missile. showing details of the four individual booster motors (**US** Army)

Description

The MIM-14 Nike Hercules is a two-stage missile with a tandem-mounted jettisonable cluster boost motor. The missile has four long cord delta wings, each with a trailing-edge control surface. These wings extend from forward of the mid-section to the front edge of the tapered boat-tail. There are also four small in-line delta fins just forward of the wings. The missile is 8.19 m long and has a body diameter of 0.54 m, which flares out to 0.8 m to match up to the boost motor. The boost motor cluster is 4.34 m long, weighs 2,350 kg and is composed of four individual boost motors banded together. It has a cross-sectional width of 0.88 m with four large clipped delta fins attached to the aft end of the cluster. The warhead can be either a 510 kg high explosive or nuclear, with the latter designated W31 and selectable at either 10 or 20 kT. The total weight at launch is 4,858 kg. In addition to the missile itself, key components of the system are: a low-power acquisition radar, high-power acquisition radar, target tracking radar, missile tracking radar, electronic data processing equipment (DCS in later versions) and remote-controlled single missile launchers. When a target is detected by the acquisition radar, it is interrogated and if judged hostile its location is transferred to the target tracking radar which pinpoints it for intercept purposes. When the target is in range the missile is normally launched at an 85° angle.

When the booster cluster has separated, the guidance system is activated, programming the missile to roll towards the target and into the intercept plane. Steering commands direct the missile to the optimum burst point. The MIM-14 has a maximum range of 145 km and an engagement envelope between 1,000 and 25,000 m.



A line diagram of the MIM- 14 Nike Hercules missile

Operational status

MIM-14 Nike Hercules entered service in 1958 and is no longer in production. Total

production amounted to over 25,000 missiles, of which 2,650 were exported under the Foreign Military Sales programme and 1,764 under the Military Aid Programme. The Nike Hercules was phased out of service in the USA in the early 1980s and has now been replaced by the Patriot system with US forces. Apart from Japan (who produced under licence), Nike Hercules was also exported to Belgium, Denmark, Germany, Greece, Italy, Norway, Spain, Taiwan and Turkey, but it is believed that most of these missiles have been taken out of service. Taiwan is replacing its Nike Hercules missiles with the Sky Bow 1/2 (Tien Kung), and Italy reduced to four MIM-14 missile squadrons in 1997. The US batteries in South Korea were transferred in 1976 to the Republic of Korea, where it is believed that two batteries of missiles are operated in an alternative surface-to-surface role. Approximately 90 launchers and 150 missiles are believed to have been transferred to South Korea in 1976 and some are reported to remain in service. There were two reported accidental launches of MIM-14 missiles from South Korea in 1997 and 1998, and a test launch in October 1999 is reported to have failed. However, a report in 2001 stated that 13 out of the last 15 flight tests have been successful. Greece started taking delivery of MIM-104 Patriot missiles in late 1999, and these are planned to replace the Nike Hercules batteries by 2003.

Specifications

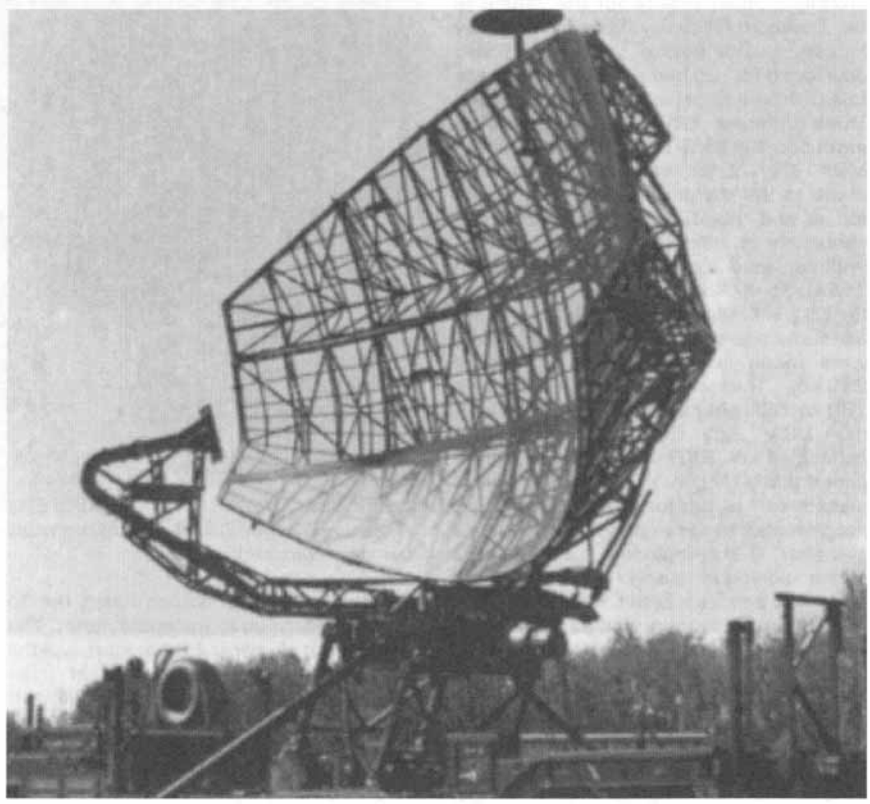
Length: 12.14 m including boost motor assembly
Body diameter: 0.54 m
Launch weight: 4,858 kg
Warhead: 510 kg HE or nuclear (W31) 10 or 20 kT
Guidance: Command
Propulsion: Solid propellant
Range: 145 km

Associated radars
Surveillance radar: HIPAR and AN-MPQ-43
Frequency: 1.35-1.45 GHz (L-band)
Peak power: n/k
Range: 250 km

Contractor

Boeing Military Aircraft and Missile Systems, St Louis, Missouri.

Two MIM-14 Nike Hercules missiles, with one erected ready for launch in the foreground
0022197



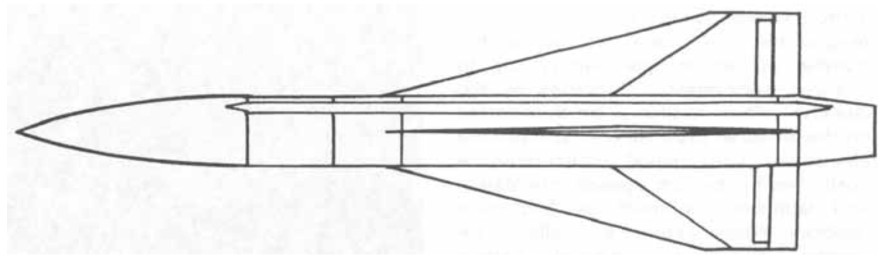
A MIM-14 Nike Hercules High Power Acquisition Radar (HIPAR)

MIM-23 HAWK

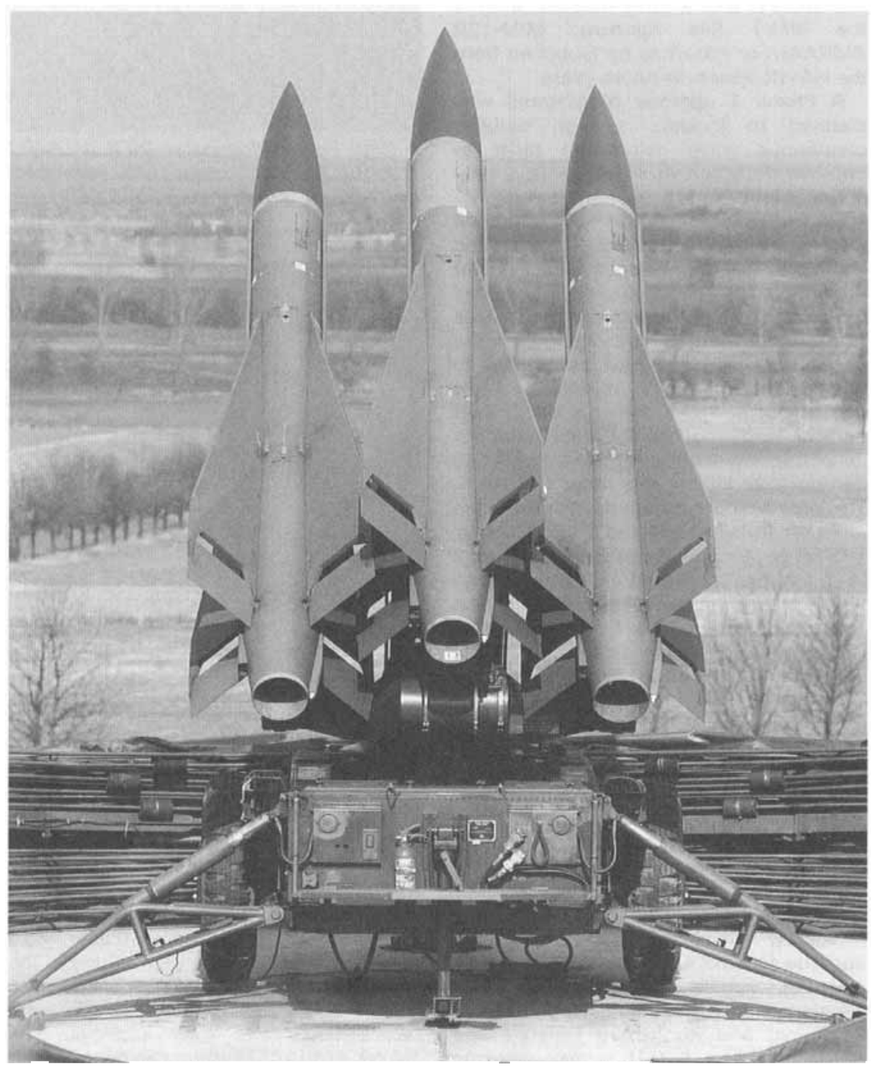
Type
Short-range, ground-based, solid-propellant, theatre defence missile.

Development
Development of the MIM-23 HAWK (Homing All the Way Killer) SAM system commenced in 1953. A year later the US Army awarded a full-scale development contract to Raytheon for the missile, and Northrop (now Northrop Grumman) to provide the launcher and ground equipment. The first test firing took place in June 1956 with the development phase completed in July 1957. Initial Operational Capability (IOC) of the basic HAWK, MIM-23A, took place in 1960 when the first US Army battalion was activated. In the same year, a NATO Memorandum of Understanding (MoU) was signed between Belgium, France, Germany, Italy, Netherlands and USA for co-production of the system in Europe. In addition, special grant aid arrangements were made to deliver European built systems to Denmark, Greece and Spain. In order to counter advanced threats, especially at low altitude, in 1964 the US Army initiated a modernisation programme known as the HAWK/HIP (HAWK Improvement Programme). This involved a number of changes to the basic system and the updating of the missile to the Improved-HAWK, MIM-23B configuration with a larger warhead, an improved small guidance package and a higher performance motor. US Army and Marine Corps HAWK battalions were subsequently retrofitted to the I-HAWK standard by 1978, and successive missile improvements have been designated MIM-23C/D/E/F/G/H/J/K/L/M. In 1974 an enlarged NATO consortium (including Denmark and Greece) awarded Raytheon a contract for co-production of I-HAWK components in Europe. In 1977 the USA started a second modernisation programme under the designation HAWK-PIP (Product Improvement Plan). This involved three phases: the PIP Phase 1 being fielded by the US forces in 1979 and including an Improved CW Acquisition Radar (ICWAR) AN/MPQ-55 transmitter to double the output power and increase detection range; the addition of digital Moving Target Indication (MTI) to the Improved Pulse Acquisition Radar (IPAR) AN/MPQ-50; and the inclusion of Army Tactical Data Link (ATDL) communications within the system.

The Phase 2 upgrade modifications were approved for production in 1983 and these improved the reliability of the Improved High Powered Illumination (IHPI) AN/MPQ-46 radar by replacing valve circuitry with modern solid-state technology. A Tracking Adjunct System (TAS) optical tracking system was added for operation in an ECM environment to the HPI, the Battery Control Centre (BCC) and the Platoon Command Post (PCP). Germany, Netherlands and Norway have modified their HAWK systems with an alternative IR acquisition and tracking system known as the HAWK Electro-Optical Sensor (HEOS) in place of the TAS. The HEOS operates in the 8 to 11 μm band and is used to supplement or to take the place of the HPI to acquire and track targets before missile launch.



A line diagram of the MIM-23 HAWK missile



Three MIM-23 HAWK missiles on their M-192 launcher 0054280

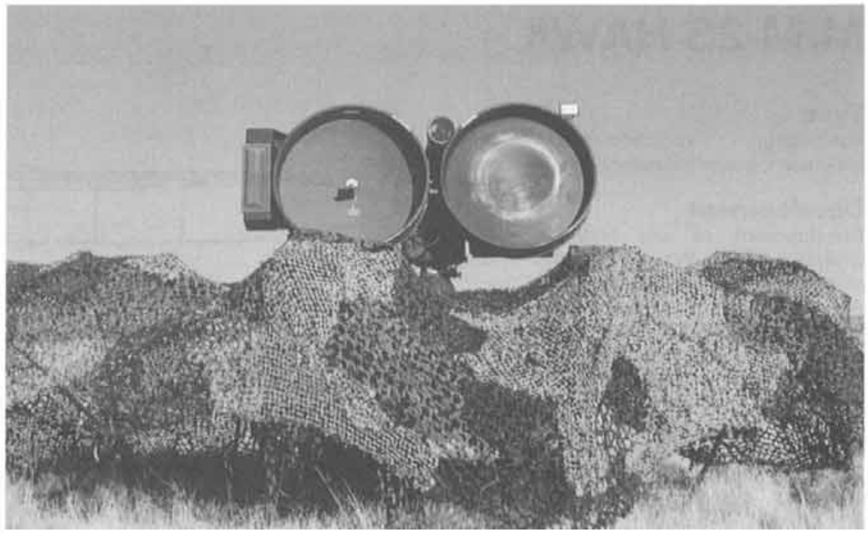
The Phase 3 upgrade programme, which started development in 1983 and entered production for the US armed forces in 1989, was successfully demonstrated against a simulated tactical ballistic missile target in April 1988. The engagement was initiated by a Patriot tracking radar AN/MPQ-53 and then transferred to the HAWK HPI radar. The Range-Only-Radar (ROR) AN/MPQ-51 and Information Coordination Centre (ICC) have been deleted from the system and the BCC replaced by a Battery Command Post (BCP). Major electronic modifications, which include the addition of distributed microcomputers and improved computer software, were made to the BCP, PCP, CWAR and HPI. However, the major system operational change made by Phase 3 is the addition of a single-screen scan target detection capability and a Low Altitude Simultaneous HAWK Engagement (LASHE) system to the AN/MPQ-61 HPIR. by employing a fan beam antenna to provide a wide-angle, low-altitude illumination pattern to allow multiple engagements against saturation raids.

A HAWK mobility survivability enhancement programme has been developed following experience in the 1990-91 Gulf War. The aim of this programme has been to reduce the number of vehicles per battery and to increase survivability. Upgrades to the launcher allow missiles to be transported on the launcher itself, as well as replacing electronics with digital equipments. A north finding system speeds orientation and launcher alignment. A field wire replaces heavy cables and allows for greater dispersion amongst battery vehicles. Further work was authorised in 1993 to modify the HAWK launcher and interfaces to enable other missiles, such as the RIM-7 Sea Sparrow, MIM-120 AMRAAM or PAC-3 to be launched from the HAWK system in future years.

A Phase 4 upgrade programme was planned to include: a high mobility continuous wave acquisition radar to improve detection of small UAVs; a new engagement radar; ARM decoys; an improved missile motor; an upgraded electro-optical tracker; improved command and control; and ATBM upgrades. The ATBM upgrades provided modifications to the radars to look upwards to a greater altitude, and changes to the missile warhead and fuse assemblies to handle faster target velocities. Trials carried out in 1991 used an AN/TPS-59 tactical long-range surveillance radar for initial tracking of ballistic missile targets, to demonstrate linking this radar to HAWK. This programme continued with successful intercept trials in 1994 and 1996. The AN/TPS-59 radars provide an increased range (475 km) and increased altitude coverage (150 km) against tactical ballistic missiles. The AN/TPS-59 upgrade for the US Marine Corps will also include a communications interface with outside systems, the Air Defence Communications Platform (ADCP), with a JTIDS datalink terminal. Two further missile developments were made between 1992 and 1996; these are known as the Missile ECM Improvement (MEI) and the missile Improved Lethality Modification (ILM). The ILM has larger warhead fragments and a modified fuze to engage faster moving short-range ballistic missile targets.

Norway developed its own HAWK upgrade scheme, known as the Norwegian Adapted HAWK (NOAH). This was developed with Raytheon, Hughes (now Raytheon) and Kongsberg Defense and Aerospace. The NOAH system became operational in 1983. Future developments were expected to include the introduction of an Agile CW Acquisition Radar (ACWAR), which was an evolution of the HAWK CW radar technology. It would perform full 3-D target acquisition over a 360" azimuth sector and large elevation angles. The ACWAR programme was initiated to meet increasingly severe tactical air defence requirements, but was terminated in 1993.

In 1996, Hughes (now Raytheon), Raytheon and Kongsberg announced a US/Norwegian agreement to jointly market a HAWK-AMRAAM system, with the capability to launch up to eight MIM-120 AMRAAM missiles from a modified HAWK universal launcher. This new system uses the AN/MPQ-64 Sentinel 3D surveillance radar, the AN/MPQ-61 Phase 3 HPIR CW engagement radar, and a Fire Distribution Centre (FDC) fitted in the HAWK battery command post shelter. The new FDC uses COTS computer workstations and new displays. The HAWK-AMRAAM system can operate with mixed launchers, carrying either three HAWK missiles or eight AMRAAM. This proposal is aimed particularly at HAWK operating countries that also have AIM-120 AMRAAM in their inventory.



A High Power Illuminator (HPI) AN/MPQ-46 engagement radar, showing the optical Tracking Adjunct System (TAS) between the two circular antennas and the rectangular Low Altitude Simultaneous HAWK Engagement (LASHE) antenna on the left of the picture

A high-mobility Continuous Wave Acquisition Radar (CWAR) AN/MPQ-55 modified to improve HAWK system performance against cruise missiles, UAV and helicopters in particular, being evaluated in 1994

A new upgrade version was offered in 1999, known as the HAWK XXI. This proposed upgrading missiles to the MEI or ILM standard, using the AN/MPQ-64 surveillance radar, the AN/MPQ-61 engagement radar, the FDC and up to eight HAWK universal launchers. This would provide interoperability with MIM-104 Patriot batteries, the ability to position launchers at up to 25 km from the battery command post, the capability to net FDCs, and to cue short-range air defence systems.

In 1995, Denmark started development of the Danish Enhanced HAWK (DEHAWK) programme, which adds a Thales RAC 3-D surveillance radar in place of the MPQ-50 IPAR, MPQ-51 ROR and MPQ-55 ICWAR radars. Fibre optic cable links and software modifications have also been added. The FIM-92 Stinger short-range SAM system has been integrated with the DEHAWK system. France and Italy have modified Phase 3 upgrades with an open software architecture developed by AMS, Raytheon and Thales. This provides improved operational flexibility to receive early warning and to share data with shorter range air defence systems.

The Iranian Air Force is reported to have modified a number of MIM-23 HAWK missiles for carriage on F-14 Tomcat fighters in the air-to-air role. Iran has also modified its ground-based HAWK systems for carriage on a convoy of 8 × 8 wheeled vehicles and adapted the launchers to carry Standard RIM-66 or AGM-78 missiles with two Standard missiles per launcher.

A modified AN/TPS-59 solid-state tactical surveillance radar, being developed for the US Marine Corps to provide early tracking of short-range ballistic missiles for HAWK

Description

The HAWK missile has a slender cylindrical body and four long cord clipped delta-wings, extending from mid-body to the slightly tapered boat-tail. Each wing has a trailing-edge control surface. The MIM-23A is 5.08 m long, has a body diameter of 0.37 m, a wing span of 1.21 m and weighs 584 kg at launch with a 45 kg HE blast/fragmentation warhead. It has a minimum engagement range of 2 km, a maximum range of 25 km, a minimum engagement altitude of 60 m and a maximum engagement altitude of 11,000 m. The MIM-23B to M versions are 5.03 m long, have a body diameter of 0.37 m and, with a larger warhead of 54 kg, weigh 638 kg at launch. The warhead has a radar proximity fuze and an impact fuze. An improved Aerojet Mk 112 motor, with a length of 2.78 m, a diameter of 0.356 m and a total weight of 395 kg was developed for the later missile versions, and has been fitted to MIM-23B to M missiles. This dual thrust boost/sustainer motor has 295 kg of C-1 polyurethane solid propellant, increases the maximum range of the MIM-23B to M versions to 35 km and maximum engagement altitude to 18,000 m. The minimum range is reduced to 1.5 km. The MIM-23 B has a peak velocity of around 500 m/sec, and the Mk 112 motor has a shelf life of 17 years. The guidance system uses an X-band CW monopulse semi-active radar seeker. The standard Phase 2 MIM-23 I-HAWK battery includes: an HQ with an AN/MPQ-50 pulse/acquisition radar; an AN/MPQ-48 CW acquisition radar; an AN/MPW-51 Range-Only-Radar; an AN/MWS-11 Improved Command Post (ICP); an AN/TWS Battery Control Centre (BCC); and two firing platoons each with an AN/MPQ-46 tracking/illuminating engagement radar and three M192 triple missile launchers. The AN/MPQ-50 Pulse Acquisition Radar (PAR) operates at 500-1,000 MHz (L-band) and is the primary source of high- to medium-altitude aircraft detection for the battery. The antenna is a 6.7 × 1.4 m elliptical reflector of open lattice construction, mounted on a small two-wheeled trailer. The radar incorporates a Digital Moving Target Indicator (DMTI) to provide sensitive target detection in high clutter areas. The PAR also includes several ECCM features and uses off-the-air tuning of the transmitter. The AN/MPQ-55 8 to 12 GHz (X-band) Improved CW Acquisition Radar (ICWAR) was introduced by the Phase 1 improvements for aircraft detection at the lowest flyable altitudes in the presence of heavy clutter. During operations the ICWAR and PAR are synchronised in azimuth for ease of target correlation. Other features include FM ranging and BITE. FM is applied on alternate scans of the ICWAR to obtain range information.

The AN/MPQ-51 Range-Only-Radar (ROR) is a 35 GHz (K-band) pulse radar that provides quick response range measurement when other radars are denied range data by enemy countermeasures. The ROR reduces its vulnerability to jamming by transmitting only when designated. The ROR is no longer used in the Phase 3 system.

The early AN/MPQ-46 8 to 12 GHz (X-band) High Power Illuminator (HPI) radars had only the two large dish-type antennas side by side, one to transmit and one to receive. The HPI automatically acquires and tracks designated targets in azimuth, elevation and range. It also serves as an interface unit supplying azimuth and elevation launch angles computed by the Automatic Data Processor (ADP) in the Information Coordination Centre (ICC) for up to three launchers. The HPI X-band energy reflected off the target is also received by the HAWK missile. These returns are compared with the missile reference signal being transmitted directly to the missile by the HPI. Target track is continued throughout missile flight and after intercept, HPI Doppler data is used for kill evaluation. The HPI receives target designations from one or both surveillance radars via the Battery Control Centre (BCC) and automatically searches a given sector for a rapid target lock on. The HPI incorporates ECCM and BITE.

Phase 2 HPIs had an optical tracking system added for operation in an ECM environment. This device, called the Tracking Adjunct System (TAS), was positioned on top and between the two radar dishes. The Israelis have upgraded the Phase 2 standard with the addition of a Super Eye electro-optical TV system for detection of aircraft at 30 to 40 km and identification at 17 to 25 km. They have also modified their system for engagements at altitudes up to 24,000 m.

Phase 3 introduced upgrades to the PAR for high altitude surveillance, to the CWAR for low altitude surveillance, to the HPIR engagement radar and incorporates the Kongsberg FDC in the battery command post. The major operational change brought about by Phase 3 to the AN/MPQ-61 HPIR is the addition of a single-scan target detection capability and a Low Altitude Simultaneous HAWK Engagement (LASHE) system. This is achieved by

A Missile Loader Transporter 5-tonne truck carrying three HAWK reloads and towing a HAWK launcher, all transportable on a C-130 Hercules aircraft

employing a fan beam antenna to provide a wide-angle, low-altitude illumination pattern to allow multiple engagements against saturation raids. This antenna is rectangular.

The Thales RAC 3-D surveillance radar, introduced with the DEHAWK upgrade, operates in C-band (4 to 6 GHz) and has a range of 100 km against fighter aircraft targets.

Operational status

The basic MIM-23A HAWK entered service in 1960 and the MIM-23B I-HAWK in 1973. I-HAWK remains in service with the following countries: Bahrain, Belgium, Denmark, Egypt, France, Germany, Greece, Iran, Israel, Italy, Japan, Jordan, South Korea, Kuwait, Netherlands, Norway, Portugal, Saudi Arabia, Singapore, Spain, Sweden, Taiwan, United Arab Emirates and USA. It is reported that ex-US Army National Guard HAWK systems will be sold to Indonesia. Belgium, Denmark, France, Germany, Greece, Italy, Netherlands and USA have implemented Phase 1 and Phase 2 improvements. Many of the other countries are following suit. The Phase 3 upgrade programme is in production for Egypt, Greece, Israel, Saudi Arabia, Spain, Sweden, Taiwan and the US Marine Corps. French and Italian HAWK batteries started to receive the Phase 3 upgrade in 2002. The HAWK-AMRAAM system is in development, and awaiting a production contract. The Danish DEHAWK upgrade has been developed and tested with around 20 firings during 1999/2000, and it is planned that 16 fire units will be upgraded. Taiwan plans to upgrade 160 missiles and some surveillance radars from 2001, using locally designed modification kits.

In the early 1980s Israel upgraded its HAWK systems in order to maintain their viability against an increasing threat. This system was used in August 1982 to shoot down a Syrian Air Force MiG-25R Foxbat-B photo-reconnaissance aircraft flying at M2.5 on a high level 21,000 m plus sortie near Jounie, north of Beirut. HAWK missiles defending Kuwait against the Iraqi invasion in August 1990 are reported to have shot down seven aircraft and one helicopter with 12 missiles launched. A US trial firing of two modified HAWK missiles against a short-range ballistic missile was successfully completed in June 1991, using a Patriot AN/MPQ-53 radar feeding data to the HAWK battery via a secure digital datalink. Between 1988 and 1997 there have been 13 tests made firing one or two HAWK missiles against MGM-52 Lance short-range ballistic missile targets, with nine rated as successful intercepts.

A modification programme was started by the US Marine Corps in 1992 to improve the performance of AN/TPS-59 radars to enable them to acquire and track tactical ballistic missiles to act as early warning sensors for HAWK batteries transferring target data using a JTIDS link. In 1994 HAWK missiles successfully intercepted two short-range ballistic missile targets, having been cued by an AN/TPS-59 radar at White Sands Missile Range. A test was also successful against a tactical ballistic missile and two low flying cruise missile targets, with simultaneous engagements. These trials also demonstrated the remote engagement section capability, with a launcher and HPI radar located several kilometres forward of the battery command post. It is reported that the US Marine Corps has 1,000 missiles with the MIM-23K ATBM capability and 11 modified AN/TPS-59 radars.

Launch of an MIM-120 AMRAAM from a modified HAWK launcher (US Army) 0022196

Specifications

MIM-23A
Length: 5.08 m
Body diameter: 0.37 m
Launch weight: 584 kg
Warhead: 45 kg HE blast/fragmentation
Guidance: Semi-active radar
Propulsion: Solid propellant
Range: 25 km

MIM-23B **to** M
Length: 5.03 m
Body diameter: 0.37 m
Launch weight: 638 kg
Warhead: 54 kg HE blast/fragmentation
Guidance: Semi-active radar
Propulsion: Solid propellant
Range: 35 km

Associated radars
Surveillance radars: AN/MPQ-50 (IPAR)
Frequency: 500-1,000 MHz (L-band)
Peak power: 1 kW
Range: 100 km

AN/MPQ-55 (ICWAR)
Frequency: 8-12 GHz (X-band)
Peak power: 400 W
Range: 70 km

AN/TPS-50
Frequency: 1.2-1.4 MHz (L-band)
Peak power: 46 kW
Range: 475 km

Engagement radar: AN/MPQ-46 (HPI)
Frequency: 8-12 GHz (X-band)
Peak power: n/k
Range: 40 km

Contractor

Raytheon Missile Systems, Tucson, Arizona.

MIM-104 Patriot

Type

Short-range, ground-based, solid-propellant, theatre defence missile.

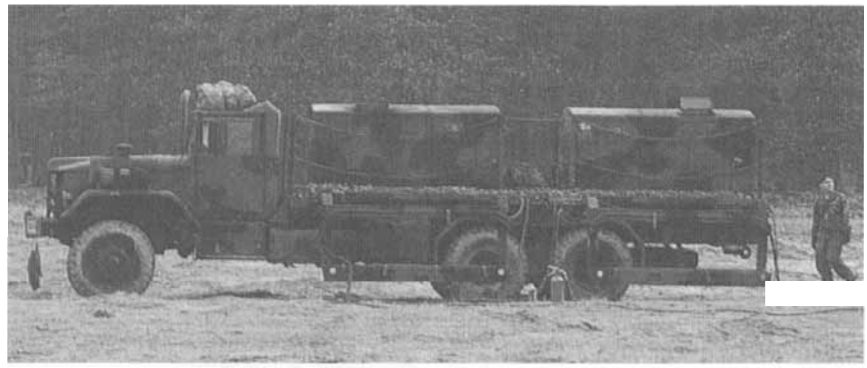
Development

The early concept of a mobile all-weather Surface-to-Air Missile (SAM) system was formulated in 1961, with Raytheon being awarded an initial development contract in 1967, for a system then called SAM-D. Flight trials took place in the early 1970s. including evaluation of the novel track-via-missile guidance system, resulting in full-scale development being authorised in 1976. MIM-104A Patriot was designed to defend against saturation raids by aircraft accompanied by heavy ECM. Problems with early missile deliveries delayed the operational acceptance of the system by the US Army until 1984. Several upgrade programmes have been initiated since the full-scale development was completed in 1982, including provision for anti-radar missile active decoys, an out-of-sector launch capability and improved ECCM for the AN/MPQ-53 phased-array radar system. MIM-104B introduced an improved capability against jammer aircraft.

The idea to modify the Patriot system to engage Tactical Ballistic Missiles (TBM) emerged in the late 1970s when the former USSR began improving the accuracy of their SS-1 'Scud' missile. The US Army decided it would be possible to adapt the Patriot system because the system was software controlled, had a capable radar, a missile with speeds in excess of M3.0 and a large warhead. The Patriot Anti-Tactical Missile (ATM) upgrades were started in 1984 and included two phases. In the Patriot Advanced Capability -1 (PAC-I) phase, modifications were carried out on the software affecting the search and track algorithms. Software changes were also made to allow the phased-array radar to view at elevation angles from 45 to nearly 90° (almost straight overhead). PAC-1 was flight tested for the first time in 1986. In the second phase, the PAC-2 missile (MIM-104C) was developed with an improved fuse and warhead, plus further amendments to the guidance algorithms. The radar, AN/MPQ-53, also had software changes to detect smaller RCS targets. The new system was flight tested for the first time in 1987 and was used against Iraqi missiles during the 1990-91 Gulf War.

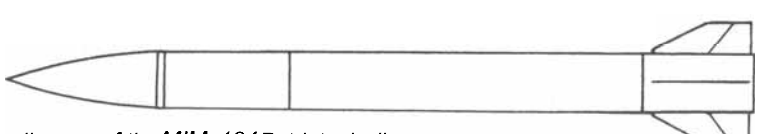
Further studies were jointly conducted by the US and Germany for a longer-range Patriot missile and a more powerful radar. This Advanced Tactical Patriot programme examined options to introduce a multimode active and semi-active radar seeker for the missile; a new motor to double the range; variable fusing through the active radar seeker or proximity fuse; improved warhead and new radome; and possibly vertical launch from a new lightweight C-130 mobile TEL vehicle, as well as further improvements to the phased-array radar system. However, in 1994 the US selected the smaller ERINT missile, which would be fitted to the Patriot launcher, with four ERINT canisters replacing one of the Patriot canisters. The ERINT missile was then renamed as Patriot Advanced Capability-3 (PAC-3). A remote launch facility, with the launchers located up to 10 km from the radar and engagement control centre, was successfully demonstrated in February 1991. This was included as part of a quick response programme of upgrades in 1992-93, that added faster launch location using north seeking gyros and GPS, and further radar improvements including a shroud to reduce interference. A Patriot PAC-2 Guidance Enhanced Missile (GEM) programme (MIM-104D) to improve lethality against tactical ballistic missiles has been developed, this includes improved seeker performance against small RCS targets and an improved fuze against high-speed ballistic missiles. The radar power is also increased and the bandwidth broadened, to improve detection range and discrimination against small RCS targets. In 2000 a GEM Plus programme was started, to provide an improved performance against low-level cruise missile targets.

The PAC-3 missile improvements are being incorporated into existing PAC-2 systems in three stages, known as configuration 1, 2 and 3. Configuration 1 was introduced in 1995, including a new pulse Doppler radar processor, the GEM missile and upgrades to the Engagement Control Station (ECS) and Information Co-ordination Central (ICC). The upgrades included the capability to record engagement data in real time. Configuration 2 was introduced in 1996, including the addition of link 16 (JTIDS)



A Patriot AN/MSQ-24 electrical power plant, containing two turbine-driven 150 kW generators

The Patriot AN/MSQ-704 Engagement Control Station and the battalion level Information Co-ordination Central vehicles are similar in appearance. using a common 6 × 6 truck and shelter



A line diagram of the MIM-104 Patriot missile

and radar improvements against small RCS targets and anti-radar missiles.

Configuration 3 was introduced in 1999, including a dual TWT and wideband facility in the radar to improve detection in a cluttered environment, improved discrimination against closely spaced objects, an increase in the remote launch range to 30 km and introduction of the PAC-3 missile. Post-deployment build 5 software, improves the radar's multifunction performance, determines threat ballistic missile launch points, and integrates Patriot with THAAD systems.

In 1996 Raytheon were awarded a development contract for an improved radar seeker for use against low-flying stealthy cruise missiles. The Patriot Anti-Cruise Missile (PACM) programme introduced a dual mode TVM and active radar seeker into the missile, similar to that originally proposed for the earlier PAC-3 project. Two flight tests were successful in July and September 1999, against low-flying drone targets, but the programme was terminated in 2000. In 1997 Lockheed Martin Missile and Fire Control Systems tested a private venture development for a Rapid Deployment Launcher (RDL) for the Patriot system, using a standard US Army 5-tonne medium tactical vehicle truck chassis. The RDL will be capable of carrying two MIM-104 Patriot missiles or eight PAC-3 missiles and the two-man crew can reload the launcher in 15 minutes. The RDL has been designed so that it can be carried in a C-130 Hercules aircraft. A common Patriot and THAAD launcher was proposed in 2001. In 2000, the US Army started development of a Service Life Extension Programme (SLEP), which introduces a HMMWV-mounted Battery Command Post (BCP) and replaces truck-mounted ICC/ECS and AMG systems with HMMWV-mounted upgraded digital electronic systems. The new vehicles will be C-130 Hercules transportable, and the HMMWV system is known as Patriot Light. The SLEP plans to extend the service life until 2030. A reliability enhancement programme was also being considered in 2000, following defects found on missiles kept for long periods on operational alert.

In 2001 the PACM programme was re-introduced, with a proposal for a 'hit-to-kill' version of Patriot using an active radar seeker with side-thrust motors. A Patriot Precision Strike (PPS) version was also proposed in 2001, using upgraded PAC-I missiles on PAC-3 standard launchers. These missiles would be used in the surface-to-surface role for use against mobile rocket launchers, with the Patriot AN/MPQ-53 radar used to locate the launcher positions.

A launch of an MIM-104 Patriot missile from White Sands Missile Range in 1986 (US Army)

Description

The Patriot missile has four moving clipped-tip delta fins at the rear, a body length of 5.2 m and a body diameter of 0.41 m. The launch weight is 914 kg, with a 90 kg HE fragmentation warhead. Patriot has a Thiokol TX-486 HTPB solid-propellant motor, with a length of 3.2 m, a diameter of 0.41 m and a weight of 635 kg. The propellant weighs 506 kg, burns for 12 seconds, and has a thrust of 10,910 kg. Later missiles use an upgraded HTPB-AP propellant with greater thrust. The missile has a weight of 408 kg after motor burn-out. The PAC-2 missile has a different warhead and fuse. The warhead fragments in the PAC-2 weigh 45 g each as opposed to the 2 g each of the earlier missile. The new fuse (M818 E2) is a pulse Doppler fuse with two conical beams, a narrow beam for missile targets and a broad beam for slower moving aircraft targets. Guidance in mid-course is inertial with command updates, with a semi-active radar Track-Via-Missile (TVM) terminal guidance system. The TVM system is required to achieve better accuracy at long range or against low-level targets. The TVM downlinks the target data received by the missile's semi-active radar receiver, in order to assist the ground-based fire-control system to discriminate the real target. This solution reduces the complexity of the missile and allows the greater processing power of the ground-based elements of the system to be used. The TVM capability is also used against jamming targets, where the home-on-jam performance is enhanced by using the ground-based processing power, enabling the fire-control system to pass commands back up to the missile. The missile has a maximum range of around 70 km against high-level aircraft targets, probably 20 km against tactical ballistic missile targets, and a reported altitude capability up to 24 km (78,700 ft).

In the field, the missiles are carried in four canisters on an M-901 trailer, with the canisters raised to about 30° for launch. The trailer is towed by a 6 × 6 tractor vehicle. The launcher trailer can be remotely located from the ECS and radar, with fibre optic cable or digital VHF radio links. The remaining vehicles transport the multifunction phased-array radar AN/MPQ-53, the Engagement Control Station (ECS) AN/MSQ-104, the Information Co-ordination Central (ICC), the two turbine driven 150 kW power generation plant AN-MSQ-24 and reload missiles. Each Patriot battery has six to eight launch vehicles and one radar, although the ECS can control up to 16 launch vehicles. Batteries can be located at up to 50 km from the ICC and spaced apart by 40 km. A battery can be set up within 45 minutes and a battalion (six fire units) set up within one hour. A typical US Army battalion has around 680 personnel. The AN/MPQ-53 4-6 GHz (C-band) frequency-agile pulse Doppler phased-array radar is automatically controlled from the ECS by the digital weapons control computer. Mounted on a trailer, it has a 5,161-element array used for search and detection, target track, illumination and missile command and uplink beams. There is also an IFF capability on the radar. At any one time the system can handle between 90 and 125 target tracks and is able to support up to

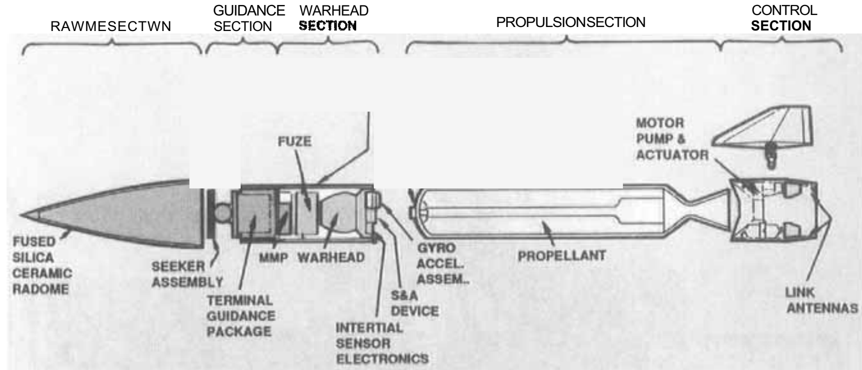
nine missiles in their final phase of engagement using TVM homing. This technique involves the missile s semi-active monopulse seeker array being directed by the ECS to look in the direction of the allocated target and receiving the reflected electromagnetic energy from the target This in turn triggers the C-band onboard downward datalink, which is offset in frequency from the target track and illumination beam The datalink transmits target data from the missile guidance package to the ECS computer via the circular 251 element TVM receive-only array, at the lower right of the radar antenna group The ECS uses this information to calculate guidance instructions, which are passed to the missile by the radar's C-band command and uplink beam. The phase-coded information is received on the missile by the two sets of guidance antenna and passed to the guidance electronics. This procedure is continuous until the point of interception, when the warhead is detonated by the fuze.

Ground radar interrogation of a target is carried out by an IFF system, using a linear antenna array set below the main radar array. There are also five diamond-shaped 51-element arrays: two individual ones above the IFF array, set at the bottom corners of the main array and a set of three centred below the level of the TVM receiver array, near the lower edge of the front face, of the radar housing. These are sidelobe cancellers used to reduce the effects of enemy jamming.

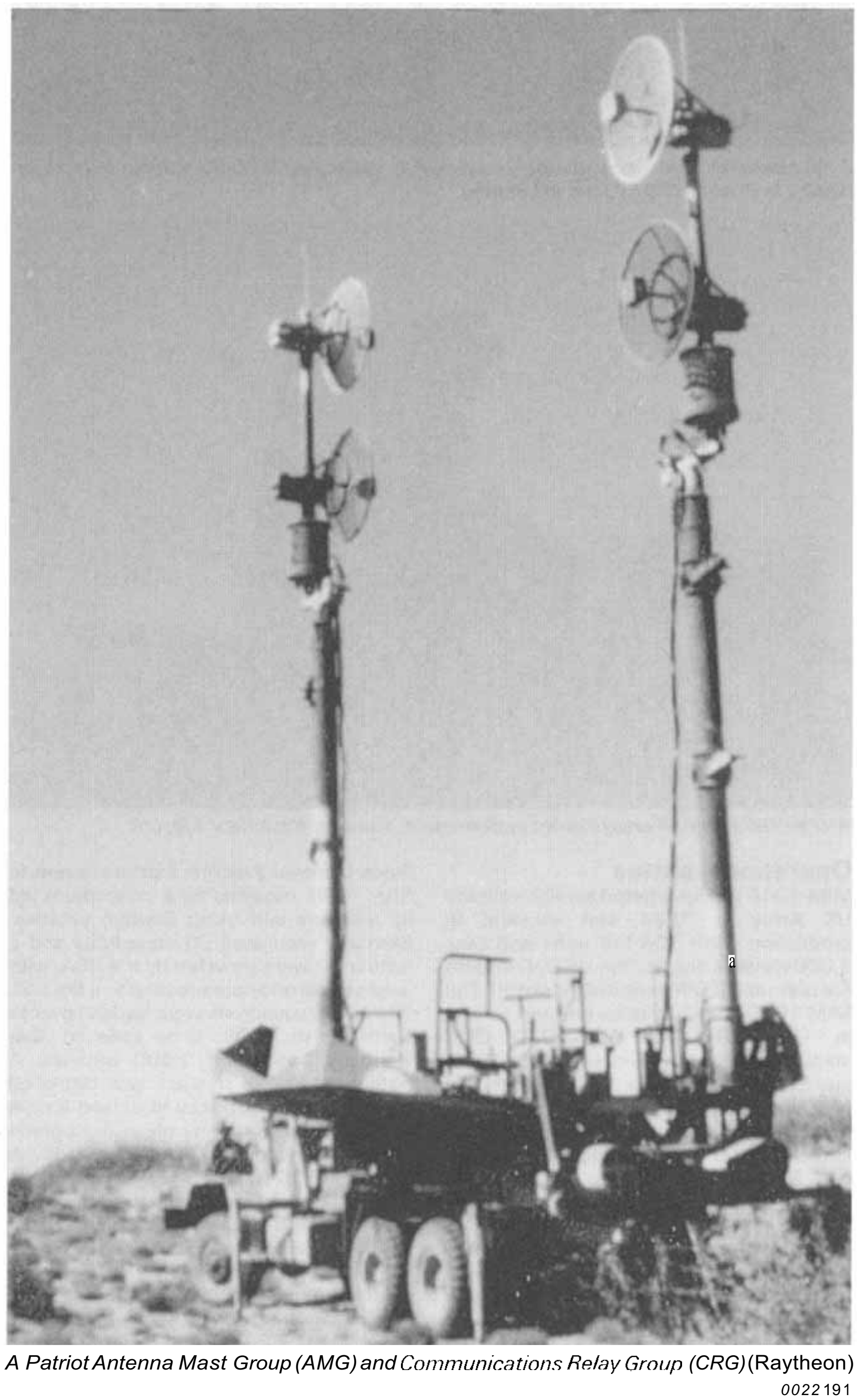
Use of Patriot against tactical ballistic missiles is enhanced if early warning of launching is available, alerting the Patriot battery and indicating a direction and time of arrival to the ground radar. It is reported that the AN/MPQ-53 radar could acquire incoming missiles at about 100 km range and that most Patriot missiles were launched automatically by the ECS.

When the engagement decision was made, either in the manual, semi-automatic or fully automatic mode, the ECS selected the launcher/s to be used and sent the pre-launch data to the chosen missiles through the datalink. It also notified the missile, at the time of launch, where to look for the target. Once in the air, the missile was acquired by the radar, this in turn initiated the missile track and command uplink beam to monitor the missile's flight and to command it to follow guidance instructions from the ECS. At a predetermined distance the TVM terminal homing was activated, and using the missile's onboard TVM track and downlink systems, the missile was steered towards the target by the commands from the ECS. Just before the missile's closest approach to the target, the warhead was detonated by the proximity fuse to produce a fragmentation pattern of heavy metal splinters.

In most of the engagements during the 1990-91 Gulf War, two Patriots were automatically fired (but monitored by controllers) from different launchers at each target. The intercepts took place at 5 to 15 km altitude at closing velocities of approximately 2 to 4 km/s.

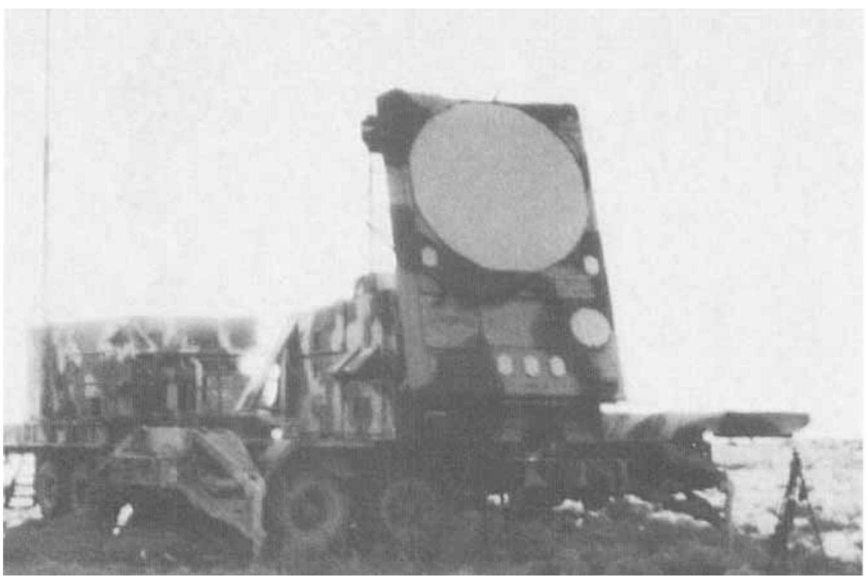


MIM-704 Patriot missile sections and major components (Raytheon) 0022190



A Patriot Antenna Mast Group (AMG) and Communications Relay Group (CRG) (Raytheon) 0022191

A four-canister launcher with the phased-array radar AN/MPQ-53 vehicle behind, on display in Paris in 1991 (Duncan Lennox)



AN/MPQ-53 phased-array Patriot system radar, showing the antenna layout

Operational status

MIM-104A Patriot entered service with the US Army in 1984 and remains in production, with 104 fire units and over 6,000 missiles built for the US DoD and 68 fire units and 3,000 missiles for export. The MIM-104C PAC-2 missiles entered service in 1991. The first MIM-104D GEM standard missiles were delivered in 1995, and by April 1999 over 1,000 missile sets had been delivered. MIM-104 Patriot exports have been made to Germany, Israel, Kuwait, Netherlands, Saudi Arabia and Taiwan, with licensed production in Japan by the Mitsubishi Corporation. Greece ordered four batteries in October 1998, with an option for two more batteries, with PAC-2 GEM standard missiles. Greece leased three fire units in 1999, for three years. Egypt requested a proposal for six batteries, with 48 launchers and 384 missiles, in October 1998. By the end of 1999, it is reported that Japan had 32 Patriot fire units and about 1,000 missiles. The German Air Force received their first Patriot systems in May 1989, modified by a consortium led by Siemens and using German vehicles. Germany requested 28 squadrons and a further 12 were provided by the USA, with each squadron approximating to a fire unit. The 12 US squadrons were handed over to Germany in 1998. It is believed that Germany has about 1,600 missiles. A battery of Patriot missiles was deployed from Germany to Turkey to defend Incirlik AFB in 1998. Germany plans to upgrade 24 squadrons to PAC-2 plus standard with some MIM-104D GEM missiles, and 12 to the PAC-3 standard. The Israelis received their missiles before and during the 1990-91 Gulf War and are believed to have three fire units and about 120 missiles. Additional radars, ECSs and vehicles were ordered by Israel in May 1998. Italy was to have built Patriot systems through a consortium called Italmissile, formed by Alenia, BPD and Oto Melara, but this programme was zero funded in 1993. Kuwait requested five Patriot fire units and 450 missiles in 1992. The Netherlands requested four fire units, 20 launchers and 160 missiles in 1984. Saudi Arabia requested eight fire units and 300 missiles in 1990 and an additional 13 fire units and 760 missiles in 1992. It is also reported that the Tien Kung (Sky Bow) missile system, manufactured in Taiwan, incorporates some technology of the Patriot system. In 1994 the USA agreed to provide Taiwan with a Modified Air Defence System (MADS) based upon the MIM-104 Patriot PAC-2 standard technology and including six fire units, missiles and related hardware, and deliveries of up to 200 missiles started in 1998. The first flight tests were made from Taiwan in June 2001, when three missiles were launched. US forces in South Korea received about five Patriot fire units and 200 missiles on detachment in April 1994, and in 1999 South Korea ordered 14 fire units and 616 missiles.

The main element of the Patriot system in operational use is the battalion, which usually has four to six batteries (or fire units). The battery or fire unit is the smallest element capable of independent operation, it comprises an AN/MPQ-53 radar, an AN/MSQ-104 engagement control station, an electric power plant and normally eight launcher stations, although up to 16 launchers can be controlled by a single engagement control station. Patriot batteries have been tested in several field exercises interoperating with MIM-23 HAWK batteries, for use against a selection of targets.

The Patriot PAC-I modification was successfully demonstrated in September 1986 against a Lance missile and the PAC-2 against another Patriot missile in November 1987. The first deliveries of PAC-2s were accelerated to begin in September 1990 in time for use in the 1990-91 Gulf War. Fire units in Saudi Arabia and Israel were loaded with a combination of the PAC-I Patriot missile and the PAC-2 version. It is estimated that around 160 Patriot missiles were launched against Iraqi Al Hussein missiles during the Gulf War in 1991. While it is believed that 81 Al Hussein missiles were launched against targets in Saudi Arabia and Israel, some missiles were not intercepted by Patriots either because no Patriot batteries were positioned and available to fire or because the Al Hussein missiles were computed to fall harmlessly into the sea. The actual Patriot success rate has not been revealed, although it would be difficult to determine a definition of success when the debris from intercepted missiles still causes damage on falling to the ground and it cannot be determined whether or not Patriot destroyed the incoming threat warheads. It is reported that in excess of 500 Patriot missiles have been launched in trials and in the 1990-91 Gulf War. Since 1991, at least 23 PAC-2 (MIM-104C) missiles and two GEM (MIM-104D) missiles have been fired against ballistic missile targets, four in June 1999 and three in June 2001, with all of them successful except for one of the earlier PAC-2 missiles.

In June 1999, five PAC-2 missiles were fired against aircraft and drone targets, and in February 2000 a successful launch was

made with a distance of 30 km between the launcher and the ECS.

In June 2001 eight PAC-2 missiles were launched by the US Army, four by the German Air Force, and one by the Royal Netherlands Air Force during the Roving Sands exercise, against three SRBM targets and ten aircraft/cruise missile targets. The first launch using Patriot Light was also made in June 2001.

Specifications

Length: 5.2 m
Body diameter: 0.41 m
Launch weight: 914 kg
Warhead: 90 kg HE fragmentation
Guidance: Command, inertial and semi-active TVM
Propulsion: Solid propellant
Range: 70 km

Associated radars
Surveillance/Engagement radar: AN/MPQ-53
Frequency: 4-6 GHz (C-band)
Peak power: n/k
Range: 170 km

Contractors

Lockheed Martin Missile and Fire Control Systems, Orlando, Florida.
Raytheon Missile Systems, Tucson, Arizona.

PAC-3 (ERINT)

Type

Short-range, ground-based, solid-propellant, theatre defence missile

Development

The Patriot Advanced Capability 3 (PAC-3) missile programme was formalised in 1994, with a contract for engineering and manufacturing development. The PAC-3 programme name is confusing, because the missile is an improved Extended Range INTerceptor (ERINT), which is being fitted into the Patriot launcher and Patriot surface-to-air missile system. The ERINT programme was a follow-on from the earlier Flexible Lightweight Agile Guided Experiment (FLAGE) Both programmes originated from an early Strategic Defense Initiative concept known as the Low Endoatmospheric Defense Interceptor (LEDI), which was seen as a lower tier defence system below the High Endoatmospheric Defense Interceptor (HEDI). LEDI was to have been a ground-launched, radar-guided, conventional HE warhead missile to intercept re-entry vehicles and tactical ballistic missiles, but the programme was stopped in 1986. FLAGE started as an experimental programme known as Short Range Hit-To-Kill (SRHIT), intended to put together a group of experiments to demonstrate the capability of a radar-guided missile to hit a re-entry vehicle target at low-altitude (below 5 km) and to validate a digital simulation of these interceptor engagements. The first series of six FLAGE flight tests from 1984 to 1986 culminated in a direct hit on a simulated re-entry vehicle, and a seventh test in May 1987 resulted in a direct hit and the destruction of a Lance SRBM target at an altitude of about 4 km (12,000 ft) ERINT was a larger missile than FLAGE, containing a fragmenting warhead and fuse to accommodate a miss distance against more difficult targets at up to 15 km altitude. ERINT was designed for use against short-range ballistic missiles, aircraft, air-to-surface, surface-to-surface and cruise missiles The PAC-3 missile will be fully integrated in the Patriot PAC-2 system, being launched from modified Patriot launch vehicles. It is planned to salvo two missiles against each SRBM target. A ship-launched SAM derivative of the PAC-3 missile was proposed in 1996 with four Ship Defence Missiles (SDM) fitted in each Mk 41 VLS cell as a complement to existing RIM-67 Standard missiles. PAC-3 has also been proposed as an upgrade to the MIM-23 HAWK system. In 1999 it was announced that the PAC-3 missile would be adopted as the initial missile solution for the international MEADS programme Future design improvements to reduce the length and launch weight of the missile have been proposed, together with higher velocity fly-out and a more accurate active radar seeker. A production cost reduction programme was started in 1999. PAC-3 has been designed to be capable of use from both Patriot and MLRS launchers, but there have been no reported tests from an MLRS launcher

A trial launch of a PAC-3 missile from a MIM-104 Patriot launcher (Lockheed Martin)
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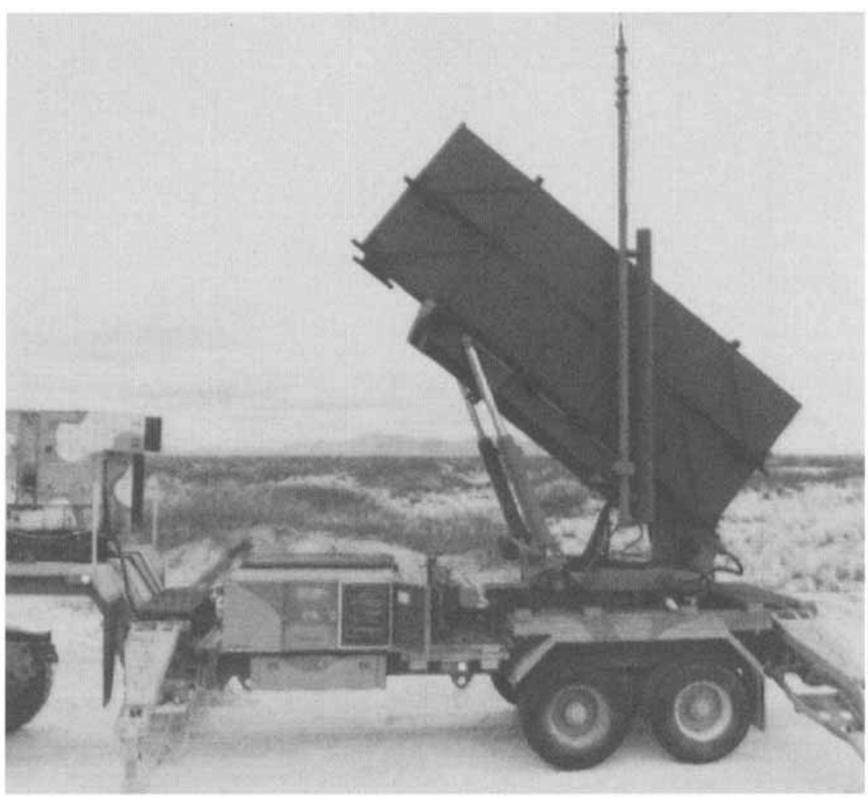
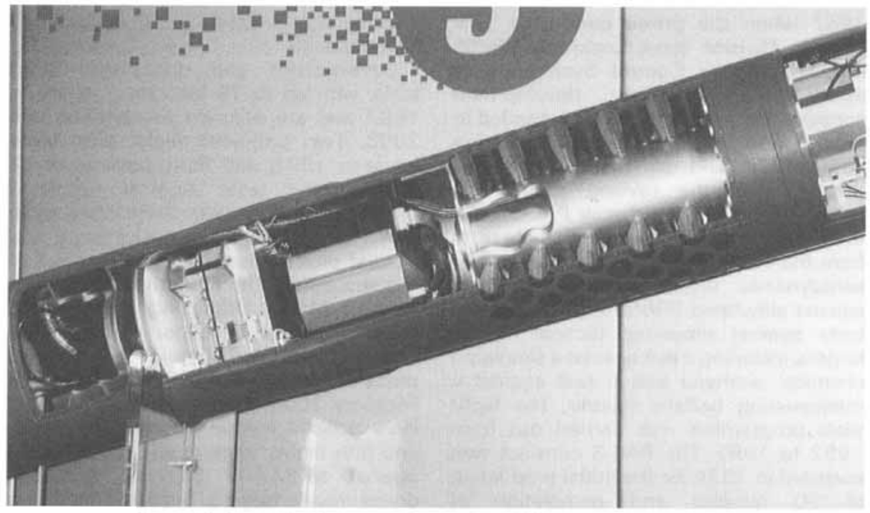


A modified MIM-104 Patriot launcher, capable of carrying four PAC-3 and three Patriot missiles or 16 PAC-3 missiles

In 1996 an agreement was signed for DASA (LFK), now part of EADS, to develop a PAC-3 capability for the German Patriot fire units, in a similar approach to that taken earlier with the German Air Force for their original MIM-104 Patriot purchase. A joint Lockheed Martin and DASA company, GLVS, may undertake final assembly, test and repair of PAC-3 missiles in Europe if orders are confirmed by Germany.

A lightweight PAC-3 launcher has been developed by Lockheed Martin to carry eight PAC-3 missile canisters and it will be C-130 Hercules transportable. This launcher is based upon a standard US Army 5-ton truck chassis, using modified Patriot M901 launcher electronics modules with GPS. The rapid deployment launcher has a total weight of 16,300 kg and a crew of two can reload eight missiles in 15 minutes. A test launch was made in November 1997.



A close-up view of the attitude control section (side thrust motors) and guidance assemblies of the PAC-3 missile (Duncan Lennox)

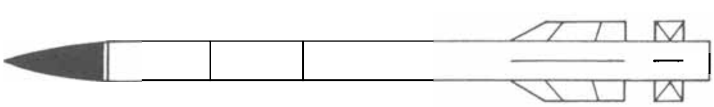
Description

The PAC-3 missile is 5.2 m long, with a body diameter of 0.26 m, a wing span of 0.48 m and a launch weight of 315 kg. The missile has four clipped-tip delta wings and four rectangular moving control fins at the tail. A ground fire-control system radar, the MIM-104 Patriot's AN/MPQ-53, is used to acquire and track the target and to pass target data to the missile prior to launch and then to provide further updates to the missile during the mid-course phase. PAC-3 uses the MIM-104 Patriot M901 launcher and the modified Patriot launch vehicle carries 16 PAC-3 missile canisters in place of four Patriot missile canisters. Alternatively, a mixed load of three Patriot and four PAC-3 could be carried by the launcher trailer. A battery can be set up within 30 to 45 minutes and the launcher can be reloaded in under one hour. The Patriot AN/MPQ-53 phased-array radar will be modified to an improved PAC-3 standard, to give a better performance against fast-moving ballistic missile targets and low-flying cruise missiles. The modified radar has increased power and range together with new discrimination, classification and identification waveforms and algorithms to separate warheads from decoys or debris. In addition, the modified radars can be positioned further away from the missile launchers, at up to 30 km.

The missile uses inertial guidance for the mid-course phase, to fly to a predetermined intercept position and it can receive data updates from the ground radar during flight. The inertial measurement unit uses ring laser gyros. In the last 2 seconds of flight the 50 W active radar terminal seeker is used. The Rockwell International (now Boeing) active Doppler radar is reported to operate in K-band (35 GHz), with the radar also acting as a fuse to detonate the warhead (sometimes described as a lethality enhancer) at the correct moment. PAC-3 is designed to hit short-range ballistic missiles and destroy them by the energy of impact, but the warhead is designed to enhance the destruction of cruise missile or aircraft targets with two rings of 12 tungsten fragments that slowly expand about the missile centreline just before impact. The missile weighs 140 kg at impact. The radome contains coolant channels to dissipate the heat generated by aerodynamic heating. PAC-3 has an ARC dual boost/sustainer solid-propellant motor, which has a length of 2.75 m, a diameter of 0.26 m and a weight of 195 kg. The motor contains 175 kg of HTPB propellant. Control is by four moving control fins at the rear of the missile, with 180 ARC solid-propellant side thrust motors mounted across the body of the missile in the forebody section. This method proved effective during the FLAGE trials, augmenting the conventional aerodynamic control fins in the terminal phase shortly before impact with the target. The missile rotates in flight at 30 rpm; this has been designed to facilitate the control of the side thrust motors and simplify the seeker scan. The missile is reported to have a range of 20 km, with a minimum intercept altitude of 50 m and a maximum of 15 km. While it is planned that the PAC-3 missiles will normally be used as part of a MIM-104 Patriot fire unit, they could also be used on their own with a Patriot modified or special PAC-3 launcher, a modified Patriot AN/MPQ-53 radar, and a modified Patriot AN/MSQ-104 engagement control station.

Operational status

The PAC-3 design programme started in 1983, but flight tests were not funded until



A line diagram of the PAC-3 missile

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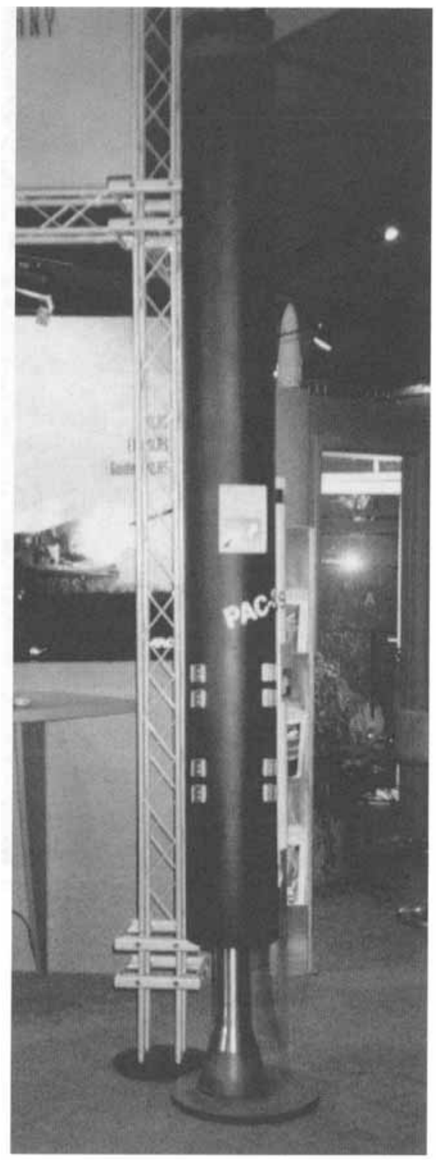
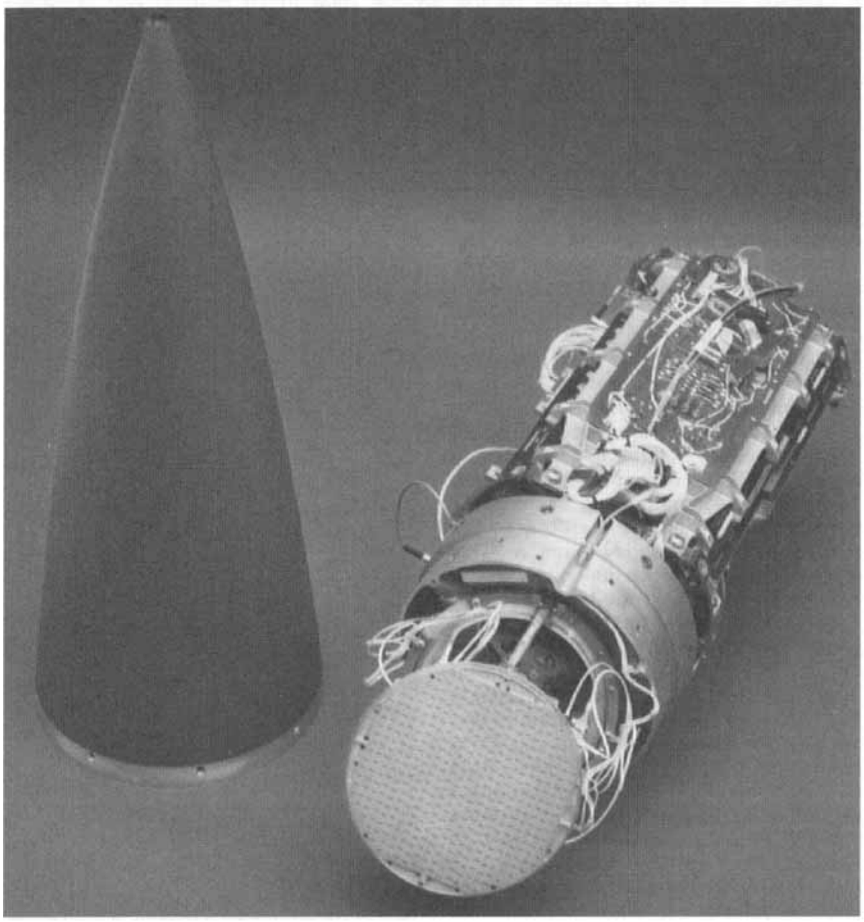


A PAC-3 missile solid-propellant motor, displayed in 2000 (Duncan Lennox)

2001/0105780

1987 when the prime contractor, LTV Missiles Division (now Lockheed Martin Missile and Fire Control Systems) was awarded a three-year development contract. The programme was extended to provide a missile capable of intercepting both SRBM and air breathing missile targets, with the revised programme known as ERINT-1 (and now PAC-3). The trials programme included eight flight tests from the White Sands Missile Range, two aerodynamic tests, four guided tests against simulated SRBM targets and two tests against simulated tactical missile targets, including a test against a simulated chemical warhead and a test against a manoeuvring ballistic missile. The flight trials programme was carried out from 1992 to 1995. The PAC-3 contract was awarded in 1994 for the initial production of 90 missiles and completion of engineering and manufacturing development.

Development and operational firing trials, with up to 19 launches, started in 1997 and are planned to continue into 2003. Two unguided flight tests were made in 1997, and there have been 12 guided flight tests. Against simulated ballistic missile targets there have been seven out of eight successful tests, and against cruise missile targets four out of five successful. The first guided flight was made in March 1999, and intercepted a ballistic missile Hera target at 12 km altitude. The second guided flight was made in September 1999 and the third in February 2000. These were also against Hera ballistic missile targets. The fourth and fifth flights were made in July 2000 against MQM-107 Streaker simulated cruise missile targets. The sixth flight was made in October 2000 against an Orbital MTTV manoeuvring ballistic missile target, with a second aircraft target in the same area intercepted by a Patriot missile.



The radome and active radar seeker assembly of the PAC-3 missile

The seventh flight in March 2001 launched two missiles at a SRBM target, the first hit the target and the second missile was destructed. The eighth flight in July 2001 fired two missiles, one against a SRBM target missed, and the second against an aircraft target resulted in a hit. The ninth test in October 2001 was successful, and was against a cruise missile target. The first operational test was made in February 2002 against a cruise missile target, but this missed. It is possible that some of the planned flight tests against cruise missile targets might be made by Patriot PAC-2 GEM missiles instead of PAC-3. Low-rate initial production contracts were placed in December 1999 and December 2000, with orders placed for 95 missiles, and it is expected that this will be followed by further orders. The 16 first production missiles were delivered in September 2001, and PAC-3 is expected to enter service in 2002, with one in every four Patriot launchers to be converted to carry the missiles. It was initially planned that 2,200 missiles would be ordered by the US Army, although reports in June 2001 suggested that this would be reduced to 1,130 missiles. The Netherlands are reported to have requested between 64 and 128 missiles in 1999 for use from 8 modified Patriot launchers, and Germany to have requested 150 to 300 missiles for use from 12 modified Patriot launchers. Other orders have been requested by Egypt and South Korea, and there are unconfirmed reports of interest from Greece, Japan and Taiwan.

Specifications

Length: 5.2 m
Body diameter: 0.26 m
Launch weight: 315 kg
Warhead: HE fragmentation
Guidance: Inertial with updates and active radar
Propulsion: Solid propellant
Range: 20 km

Contractors

Lockheed Martin Missile and Fire Control Systems, Dallas, Texas.
Boeing Space and Communications Group, Seal Beach, California.

RIM-7/-162 Sea Sparrow/ESSM

Type
Short-range, ship- and land-based, solid-propellant, theatre defence missile.

Development
From the mid-1950s. the US Navy recognised that traditional gun short-range defence against fixed-wing aircraft was no longer sufficient. In 1959 they considered using a version of the US Army's RIM-46 Mauler, but this proved inadequate and in March 1964, a shorter-range system using the AIM-7 Sparrow air-to-air missile was considered. The cancellation of the Mauler programme in 1965 led to the decision to develop Sea Sparrow. An interim solution, RIM-7H. was derived from the AIM-7E Sparrow. When used with a modified ASROC eight-tube launcher carried on an automatic gun mounting, it was known as the Basic Point Defense Missile System (BPDMS) and was delivered from October 1967 with a dual air defence and anti-fast attack craft role. These systems were produced but their performance against anti-ship missiles, fusing and ECCM capability were regarded as limited. Due to these shortcomings, the USA continued to develop the system under the Improved Point Defense Missile System (IPDMS) and this entered production in 1973 as the RIM-7F. as it was based upon the AIM-7F design.

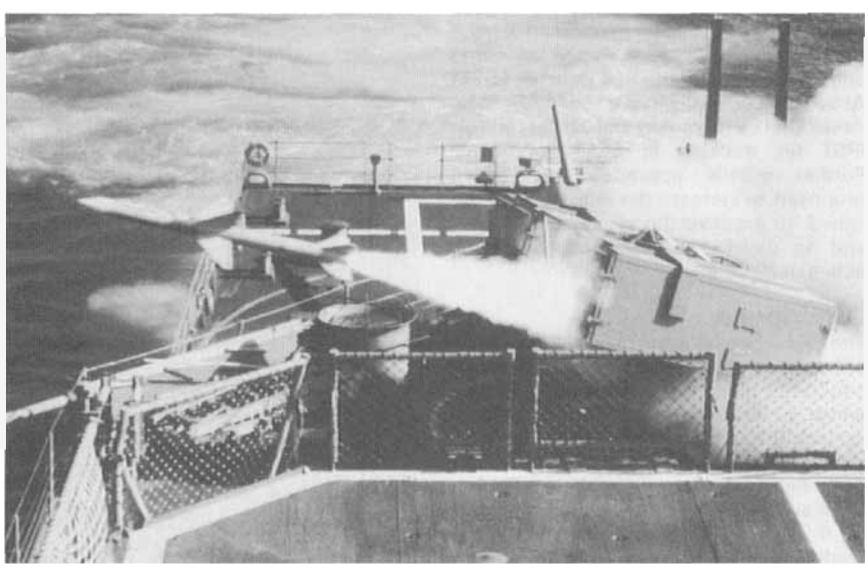
The NATO Sea Sparrow development programme was established following a Memorandum of Understanding (MoU) in 1968 between Belgium, Denmark, Italy, Norway and the USA for joint development of a system to be known as NATO Sea Sparrow Surface Missile System (NSSMS), Mk 57. The NSSMS programme now has 13 nations: Australia, Belgium, Canada, Denmark, Germany, Greece, Italy, Netherlands, Norway, Portugal, Spain, Turkey and the USA. The Mk 57 system used the earlier version of the Sparrow 3 family, which was based upon the AIM-7E2 and designated RIM-7H. This system used an octupal Mk 29 rotatable launcher. The first successful shipborne launch took place in 1972. The AIM-7M/RIM-7M with its inverse monopulse semi-active radar seeker, improved ECCM with digital microprocessing, new warhead, new active radar fuse and a new motor, entered service in 1983. Development continued in order to provide a vertical launch capability for NSSMS through development of the Guided Missile Vertical Launch System (GMVLS). This was successfully tested in 1981, using a jet-vane control system to manoeuvre after launch, and this system eventually became the Mk 48 Sea Sparrow vertical launch system. The VL Sea Sparrow was subsequently adopted by the navies of Australia, Canada, Germany, Greece, Japan, Netherlands, New Zealand, Thailand and the USA. A land-based version of RIM-7M Sea Sparrow was exported together with the Oerlikon-Contraves Skyguard system in the 1980s, and this system could fire AIM-7E/F and AIM-7M missiles as well. A modified Skyguard fire unit contains two Sea Sparrow quadruple launchers with integral engagement illuminator radars. A further version of the missile, the AIM-7P/RIM-7P, began development in 1987 and early production missile deliveries started in 1991. This version introduced further improvements to the fuse and electronics, aiming to improve the performance against sea-skimming anti-ship and cruise missiles. The missile can be fired from existing launchers, or four can be accommodated in each cell of a Mk 41 VLS. The latest Sparrow version, AIM-7R/RIM-7R, started development in 1988 as the Missile Homing Improvement Programme, with the addition of a multimode IR and semi-active radar seeker to improve performance against jamming targets.

RIM-7 Sea Sparrow is fitted to US aircraft carriers of the 'Nimitz', 'Enterprise', 'Kitty Hawk', 'John F Kennedy' and 'Forrestal' classes in three octuple Mk 29 launchers; to destroyers of the 'Spruance' class in a single octuple launcher; to amphibious ships of the 'Blue Ridge' and 'Wasp' classes, to fast combat support ships of the 'Supply' and 'Sacramento' classes and to 'Wichita' class replenishment oilers in a single octuple launcher.

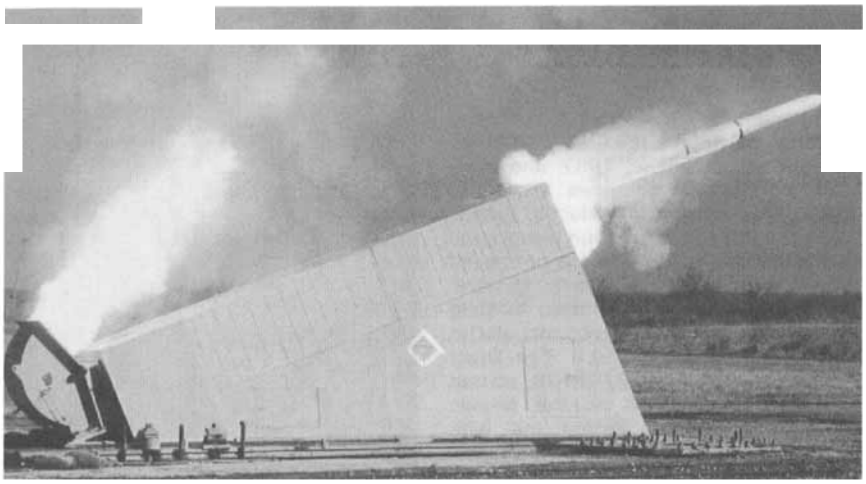
In 1988 a NATO industrial consortium started to promote two substantially developed variants of the Sparrow family, to meet the requirements for both interim and full implementations of the NATO Anti-Air Warfare System (NAAWS) and to upgrade existing Sea Sparrow installations. The interim Sea Sparrow was a lower cost improvement, while the Evolved Sea Sparrow Missile (ESSM) would be virtually a new missile and considerably larger than RIM-7. However, by 1995 the Evolved Sea Sparrow Missile programme had matured and an engineering and manufacturing development contract was awarded by NATO to a consortium of 22 companies led by Hughes (now Raytheon), with companies from the USA, Australia, Canada, Denmark, Germany, Greece, Netherlands, Norway, Spain and Turkey. The ESSM was originally designated

*A vertically launched RIM-7M Sea Sparrow missile during a trials programme in 1988. using the **Mk** 48 lightweight VLS*

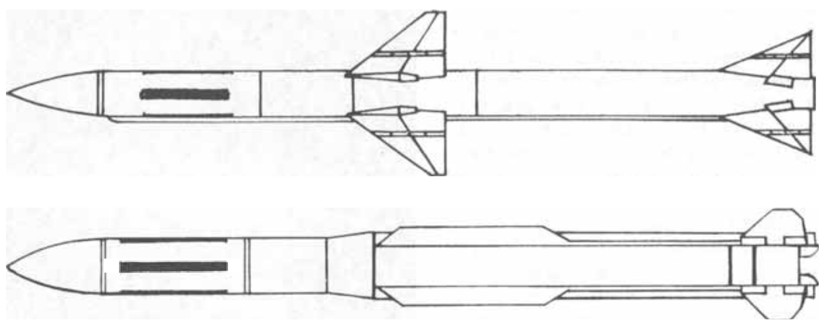
RIM-7PTC, but this has now been changed to RIM-162. It is believed that there will be several versions of RIM-162 missile, depending on the launcher used and the command links. RIM-162A will be used on Aegis ships, with Mk 41 VLS and using the S-band uplink to the missile from the AN/SPY-1 radar. RIM-162B will be used with Mk 41 VLS, but on ships with an X-band radar uplink to the missile. RIM-162C will be used with the Mk 48 VLS, on ships with an X-band radar uplink. RIM-162D will be



*Launch of a **RIM-7P** Sea Sparrow missile from an octuple Mk 29 launcher*



An Evolved Sea Sparrow Missile (ESSM) test launch (US Navy) 0054278



***A** diagram of the RIM-7M Sea Sparrowmissile. upper, and below, a RIM- 162* (Evolved Sea Sparrow Missile) 0022198

used from the Mk 29 launcher, but this missile will not have a thrust vector control assemblyfitted. All the versions will use an X-band downlink.

A new Mk 25 'quad pack' has been developed for launching four RIM-I62 ESSM from a Mk 41 VLS. A new lightweight launcher, to replace the on-deck trainable Mk 29 Sea Sparrow launcher assembly, has also been developed using the Mk 25 'quad pack' design. This launcher will hold four missiles in a VLS pack at a fixed launch angle and is intended for use with the ESSM. A first test firing was made in January 1998.

Future developments being considered by NATO for the ESSM include an X-band multifunction surveillance and engagement radar, the Self-defence ESSM Active Phased Array Radar (SEAPAR) to be developed by Raytheon and Thales, and an IRST for tracking in ECM conditions. Further missile upgrades have been proposed, to increase the range and fly-out speed, to improve the warhead and fuze, and to develop a dual-mode IIR/semi-active radar seeker.

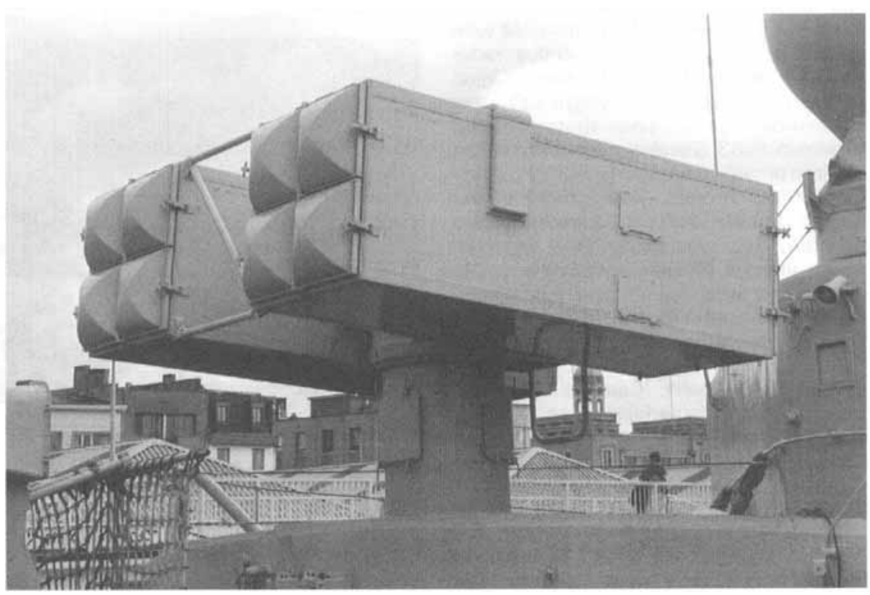
Description

The RIM-7 Sea Sparrow has the same basic airframe as the air-to-air missile, the only structural difference being the folding-wings which are required for the launch system. It has four moving delta wings at mid-body and four fixed in-line clipped delta fins at the rear. RIM-7H (NATO Sea Sparrow) is 3.66 long, has a body diameter of 0.2 m and a 30 kg continuous rod warhead. The complete missile weighs 205 kg at launch. RIM-7F is 3.66 m long, has a body diameter of 0.2 m and, with a 39 kg warhead, weighs 227 kg at launch. The guidance system used in both RIM-7H and RIM-7F missiles is inertial for mid-course with a conical scan semi-active radar seeker that is relatively easy to jam. Propulsion is by a boost sustain solid-propellant motor (Mk 38 or Mk 52). which gives the missile a speed of M2.5, a maximum range of 15 km, and an intercept altitude envelope of 15 to 5,000 m.

The RIM-7M is the same size as RIM-7F/H but weighs 231 kg at launch. It has an improved guidance system with inertial mid-course with an inverse monopulse semi-active radar and digital processing which gives the missile a greatly improved ECCM capability. RIM-7M also has an active radar fuse and a focused blast/fragmentation warhead. All this, together with a built-in test system, has provided a more reliable missile capable of attacking low-flying, high-speed targets. Propulsion is by a boost sustain solid-propellant motor (Mk 58 Mod 0), which gives the missile a speed of M2.5. a maximum range of 15 km, and an intercept altitude envelope of 15 to 5,000 m. RIM-7P introduced further fuse and electronics improvements and with the addition of a Jet Vane Control (JVC) unit can be launched from the Mk 41 VLS. The JVC unit is then jettisoned as soon as the missile has reached the required trajectory and direction to intercept the designated target. RIM-7P also contains improved guidance algorithms to provide better performance against low-level fast targets.

The RIM-7R is similarto the RIM-7M/-7P missiles, but has a dual-mode IR and semi-active radar seeker. The IR seeker, taken from the AIM-9 Sidewinder programme, is uncovered after launch and searches to acquire the target, then guides the missile to an intercept. If the IR seeker fails to achieve lock-on to the desired target, then the semi-active radar seeker takes over. This version is slightly heavier, at 232 kg launch weight, and uses a modified Mk 58 Mod 4 solid-propellant boost sustain motor. RIM-7R alters the control from moving wings (on all earlier RIM-7 versions) to moving tail fins, to improve the manoeuvrability.

The NSSMS uses the Mk 29 Guided Missile Launcher Subsystem (GMLS) which consists of an eight-cell launcher, a deck station launcher control unit and a launcher control cabinet. The launcher carries two four-cell clusters attached to a pedestal that moves them both in elevation and azimuth. The missiles with their wings folded are kept ready to fire in their cells, protected by frangible covers: the sealed cells are also fitted with heaters against cold weather and ice. The NSSMS Fire-Control System is designed for a range of



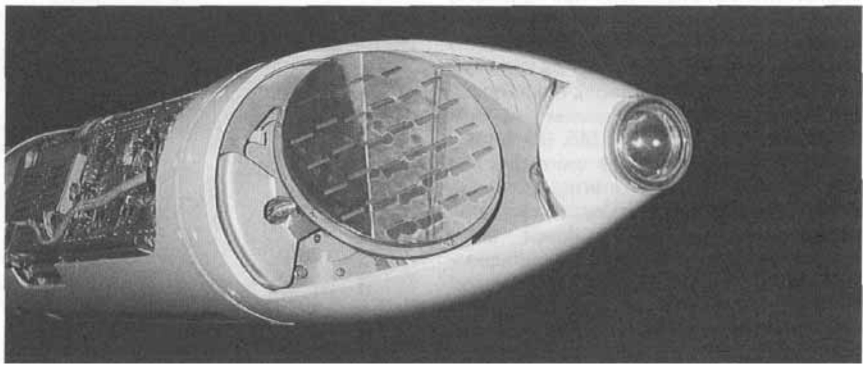
A Mk 29 octuple launcher for RIM-7 Sea Sparrow (van Ginderen) 0054279

Specifications

	RIM-7H	RIM-'IF	RIM-7M/P	RIM-I 62 (ESSM)	RIM-7R
Length	3.66 m	3.66 m	3.66 m	3.7 m	3.66 m
Body diameter	0.2 m	0.2 m	0.2 m	0.254 m	0.2 m
Launch weight	205 kg	227 kg	231 kg	282 kg	232 kg
Warhead	30 kg HE continuous rod	39 kg HE blast/fragmentation	39 kg HE blast/ fragmentation	39 kg HE blast/ fragmentation	39 kg HE blast/fragmentation
Guidance	semi-active radar	semi-active radar	semi-active radar	semi-active radar	semi-active radar and IR
Prooulsion	solid propellant	solid propellant	solid propellant	solid propellant	solid propellant
Range	15 km	15 km	15 km	30 km	15 km

operational modes, from manual to fully automatic (the operator's consent is always required, before a missile can be fired). Given its semi-active radar homing, the system can only engage a single target per Tracking Illuminating Radar (TIR). Most NSSMS installations have one or two TIRs, but it is possible however to use a single radar to engage two closely spaced targets coming from the same direction. The Guided Missile Vertical Launch System (GMVLS) Mk 48 requires a missile with folding wings and the addition of a tail-mounted jet-vane controlled booster motor unit, to provide a fast transition from the vertical. The boost motor unit is 0.37 m long and weighs an additional 18 kg. RIM-7M and -7P missiles can also be adapted for vertical launch. The Mk 48 launcher is used in four versions: mod 0 has two missiles and is mounted on deck; mod 1 has two missiles bulkhead mounted to the side of a hangar or superstructure; mod 2 has 16 missiles in packs of four mounted below decks; and mod 3 is a compact low weight on deck module for six missiles. A Mk 22 canister is used to enable RIM-7 Sea Sparrow missiles to be launched from the Mk 41 VLS, with four missiles loaded into each Mk 41 unit.

The Evolved Sea Sparrow Missile (ESSM), designated RIM-162, is 3.7 m long, has a rear body diameter of 0.254 m and weighs 282 kg. The larger rear body diameter is to accommodate a larger and more powerful solid-propellant boost and sustainer motor. The missile has a digital inertial measurement unit and autopilot, with S-band (2 to 4 GHz) or X-band (8 to 12 GHz) uplinks and X-band downlinks. It is planned to pack ESSM with four missiles per Mk 41 VLS cell in a new Mk 25 'quad pack' assembly, which will house 32 ESSMs in the space of 8 RIM-7M/P missiles. The Mk 25 system gives a 32-missile load in the Mk 41 VLS a total weight of 29,180 kg. The longer ESSM missile will still fit the existing on-deck Mk 29 launchers. The missile will have small fixed rectangular short chord wings and four tail-mounted hinged fins for control with TVC in the motor nozzle. ESSM will continue with the semi-active radar seeker and Mk 139 warhead of RIM-7P, but with a larger motor will have increased speed and manoeuvrability as well as a range increased to 30 km. Later plans for ESSM include a version using the dual-mode IR



A close-up view of a pioposed Raytheon dual-mode IR and semi-active radar seeker exhibited in 1994. and developed for the RIM-7R (Duncan Lennox)

and semi-active radar seeker of RIM-7R with the tail control ESSM assembly added. The US Navy have said that they will use the AN/SPY-1 surveillance radar and AN/SPG-62 engagement radar of the Aegis/Standard missile systems with their ESSM, when ESSMs are fitted to Aegis ships. Germany and the Netherlands plan to use a Thales SMART-L 3D L-band surveillance radar with a range of 400 km, together with a Thales APAR X-band active phased array engagement radar and a Thales Sirius dual band (3 to 5 and 8 to 10 microns) IRST with a range of 30 km.

Operational status

RIM-7H Sea Sparrow entered service in 1967, followed by RIM-7F in 1973, RIM-7M in 1983, RIM-7P in 1991 and the latest version RIM-7R in service in 1997. A total of 150 NSSMSs and over 11,000 Sea Sparrow missiles have been produced with approximately 60 per cent going to the USA and the others to the following countries: Australia, Belgium, Canada, Denmark, Germany, Greece, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Thailand, Turkey and UAE. Brunei and South Korea have also ordered missiles. The Sea Sparrow is also co-produced with substantial licence production content in Japan by Mitsubishi Electric Company (Melco). Kuwait ordered Amoun land-based RIM-7 missiles from Egypt.

RIM-162, the Evolved Sea Sparrow Missile (ESSM) entered the design study phase in 1992, engineering and manufacturing development started in 1995 and the first flight trial was made in September 1998. Motor tests from Mk 29 and Mk 48 launchers were started in 1997. Around 15 development evaluation tests are planned, with the first made from White Sands missile range in March 2000 against a BQM-34 Firebee drone target.

The first ship-launched missile test with a live warhead was made in November 2001. Low rate initial production was authorised in August 2001, for 255 missiles. RIM-I62 (ESSM) is expected to enter service in 2003, with around 4,000 missiles planned for the production phase. The US Navy plans to use ESSM as part of the new Ship Self Defence System (SSDS) together in an integrated system with RIM-I 16 RAM missiles, Phalanx guns, chaff, flares and jammers from aircraft carriers, LPD and LSD. In 2001 the USN decided to fit ESSM to Ticonderoga (CG-47) class Aegis cruisers. Orders for ESSM have also been placed by Australia, Canada, Germany and Netherlands.

Associated radars
Surveillance radar: Mk 23 TAS
Frequency: 1-2 GHz (L-band)
Peak power: n/k
Range: 185 km

Engagement radar: Mk 91
Frequency: 8-12 GHz (X-band)
Peak power: n/k
Range: 25 km

Contractor

Raytheon Missile Systems, Tucson, Arizona.

RIM-66/-67/-156 Standard SM-l/-2 and Standard SM-3

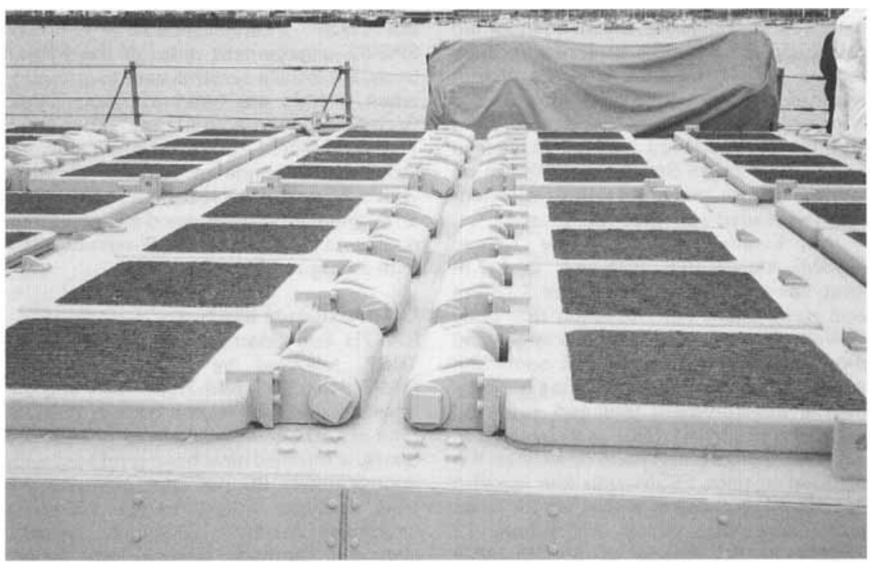
Type
Short- and medium-range, ship-based, solid-propellant, theatre defence missiles.

Development
The RIM-66 Standard missile was developed in the 1960s as a replacement for the RIM-24A Tartar surface-to-air missile for the US Navy. The incremental improvement of this system has continued for over 30 years, with Standard missile versions from RIM-66A to -66M. RIM-66 Standard versions are known as SM-1MR and SM-2MR (medium range); the principal differences between the earlier SM-1MR (RIM-66A/B/E) and SM-2MR (RIM-66C/D/G/H/J/K/L/M) missiles were that the SM-2 incorporated an inertial guidance system and updated the conical scan semi-active radar terminal guidance to a monopulse semi-active radar. A surface-to-surface anti-radar homing version of SM-1MR (RGM-66D)was developed in the early 1970s and the air-launched variant of this, the AGM-78 Standard, is believed to still be in service with the US Navy. SM-1 missiles are single-stage and present build standards are block 6, 6A and 6B. SM-2 single-stage missiles are known as Tartar or Aegis categories, with present build standards block 2, 3, 3A and 3B.

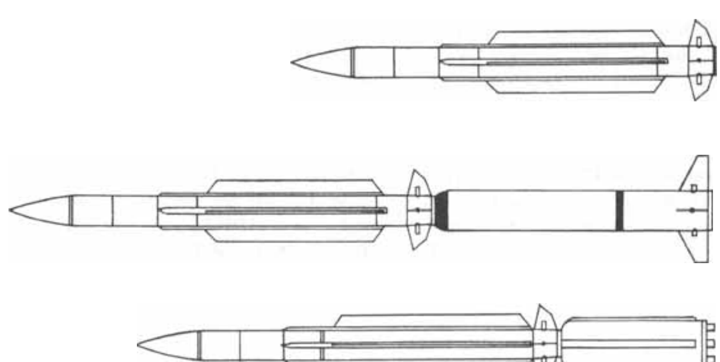
RIM-67 Standard was developed in the 1970s. The first version, RIM-67A, was to have been an active radar homing ship-to-ship missile, but this was cancelled in 1975 in favour of the Harpoon system. RIM-67B was a replacement for the longer-range RIM-2 Terrier surface-to-air missile and was known as Standard SM-1ER (extended range). The original SM-1ER missiles have all been modified or replaced in service by the later SM-2ER (RIM-67B/C/D) versions incorporating the inertial guidance and monopulse radar of the SM-2MR. The SM-PER missile has an additional tandem boost motor to give a longer range and faster fly-out capability. This missile was planned to have an optional small nuclear warhead, as Terrier, but this was cancelled in 1986. SM-2 two-stage missiles are known as Terrier block 2 and 3. Block 3A upgrades introduced an improved warhead, and block 3B introduced a dual-mode IIR seeker to augment the semi-active radar seeker. Engineering and manufacturing development of block 3B was completed in 1997, and low-rate initial production deliveries were completed by October 1998.

Standard SM-2MR and SM-PER missiles have been adapted for use with the Aegis fire-control system providing an area air defence capability for ships against high- and low-level aircraft and missile targets. The AN/SPY-1 multifunction, phased-array radars provide target and missile track functions and pass target designation data to the missile engagement radars. A dual-mode IIR and semi-active radar seeker has been developed under a joint AIM/RIM-7R Sparrow/RIM-67 Standard programme and this forms part of the block 3B upgrade package to SM-2ER missiles. The latest development of the Standard missile, RIM-156A, called SM-2ER block 4 (Aegis

The two forward facing AN/SPY-1 radar antennas on the bridge of an 'Arleigh Burke' class destroyer. Centre are a Mk 45 gun, a Mk 15 CIWS Phalanx gun and above the bridge a Mk 82 (AN/SPG-62) Standard missile system engagement radar (Barbara Parker) 0054264



Mk 41 VLS hatches on an Arleigh Burke class destroyer, which has 29 cells forward and 61 cells aft (Barbara Parker) 0054262



Line diagrams **of** *the Standard SM-2MR (top), SM-2ER (centre) and SM-2ER block 4 (bottom)*

ER), incorporates a vertical launch capability, as well as improved guidance and control systems to give this latest version an improved anti-missile capability against both steep diving and sea-skimming missile threats.

The dual-mode IIR and semi-active radar seeker developed for Standard block 3B upgrades, together with warhead and fuze upgrades, were being developed to give the later Standard SM-PER block 4A (RIM-156B) missiles a capability against short-range ballistic missiles. The RIM-156B was referred to as the Navy Area Defence (NAD) or Navy Area Theatre Ballistic Missile Defence (NATBMD) system, or as ballistic missile lower tier defence. This programme was halted in December 2001. The US Navy planned to modify their Aegis-equipped cruisers to include the Linebacker and Cooperative Engagement Capability (CEC) when fitting RIM-156B missiles, but it is not clear what will happen now. The SM-PER block 4A (NAD) started engineering and manufacturing development in 1997, and this was planned to complete in 2003. In early 2002 there were proposals to fit an active radar seeker and side thrust motors to RIM-156B missiles, or to fit PAC-3 missiles onto ships instead.

Standard SM-3, also known as Sea-based Mid-course Defense (SMD) segment, will fit the Lightweight ExoAtmospheric Projectile (LEAP), to the vertically launched SM-PER block 4 (Aegis ER) missile, for sea-based theatre-wide ballistic missile defence aboard ships. This version will have three motor stages, having a third-stage rocket motor added. The fourth-stage LEAP is now known as the kinetic warhead, and contains a LWIR seeker as well as a divert and attitude control system. SM-3 was also referred to as the Navy Theatre Wide (NTW) missile system, or as a ballistic missile upper tier defence. SM-3 is expected to be developed in two or three versions, with the initial block 1 missiles having a single-colour IIR seeker and a solid-propellant divert and attitude control system. This missile is expected to have a warhead fitted, probably using tungsten rods.

The block 2 version is expected to have a two-colour IIR seeker with new algorithms to discriminate between warheads, decoys and debris. In addition the block 2 missile may have larger motors to increase the fly-out speed. In 1999, discussions started with Japan regarding a joint USA/Japanese research and development programme for SM-3 block 2. Japan will join in the research and development of the nose cone, warhead, dual-colour IIR seeker and second-stage motor. The first SM-3 flight round was delivered in August 1999 and test launched from the USS *Lake Erie* in September 1999.

The AN/SPY-1 radar and Aegis fire-control system were having upgrades to adapt them for ballistic missile threats and compatibility with the Standard block 4A missiles, including radar search at higher elevation angles and longer ranges. In addition, AN/SPY-1 radars will be capable of being cued by DSP early warning satellites. Further improvements are being researched, including the use of wideband

Two AN/SPG-55 Standard missile engagement radar antennas, with a 3-D surveillance AN/SPS-48 above

waveforms and upgraded radar processing, for use with the SM-3 programme. The US Navy is considering the development of a separate X-band High Power Discriminating (HPD) radar, using THAAD GBR components to improve the existing Aegis system performance against longer-range ballistic missile targets.

In 1994 plans were announced for a trial to modify Standard missiles for use against land targets in the surface-to-surface role. This missile variant has been called 'Strike Standard' and then SM-4 Land Attack Standard Missile (LASM). The LASM design proposal uses modified SM-2MR block 2 and block 3 missiles, exchanging the semi-active radar seeker for a GPS guidance unit, offering an accuracy of 13 m CEP over a range of 95 km. The Mk 125 HE warhead would be modified as well. The US Navy selected this option in 1999, and flight tests were planned for 2002 to 2004.

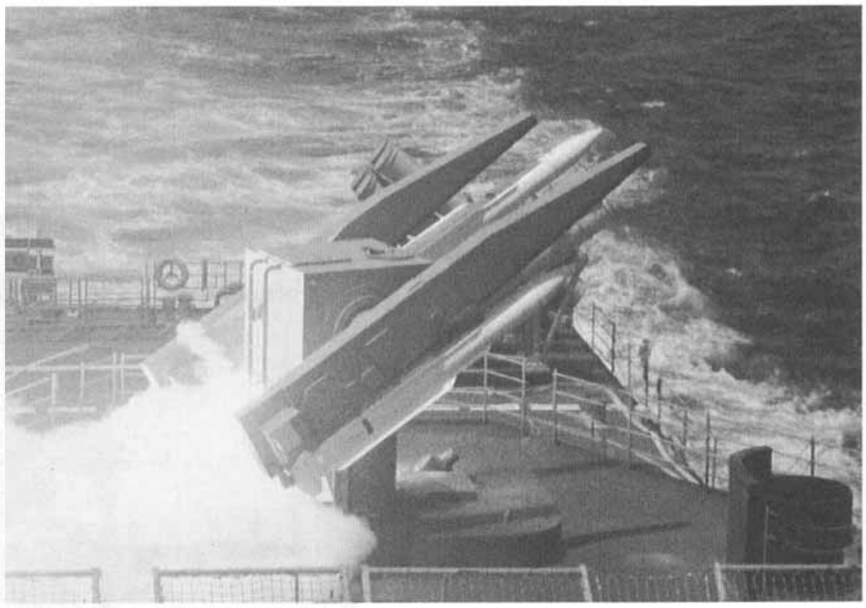
An SM-5 proposal was made in 1999, to defend against low flying cruise missiles at long range over land. This was to use a dual-mode active/semi-active radar seeker in the missile, with over-the-horizon target data being provided by CEC or from an E-2C Hawkeye aircraft.

In 1998 it was reported that Iran had modified some Standard SM-1 missiles for carriage by F-4 Phantom aircraft and had also modified some MIM-23 HAWK launchers to fire SM-1 missiles for SAM or surface-to-surface use.

Standard RIM-66 and RIM-67 missiles have been fitted to the following US Navy ship classes; 'Ticonderoga', 'California', 'Virginia' and 'Bainbridge' cruisers; 'Arleigh Burke', 'Oliver Hazard Parry' and 'Kidd' destroyers. The 'Ticonderoga' cruisers and 'Arleigh Burke' destroyers have Aegis weapon systems, AN/SPY-1 radars and Mk 41 vertical launch systems.

Description

The RIM-66 Standard SM-1MR and SM-2MR missiles have four narrow rectangular wings and four moving clipped



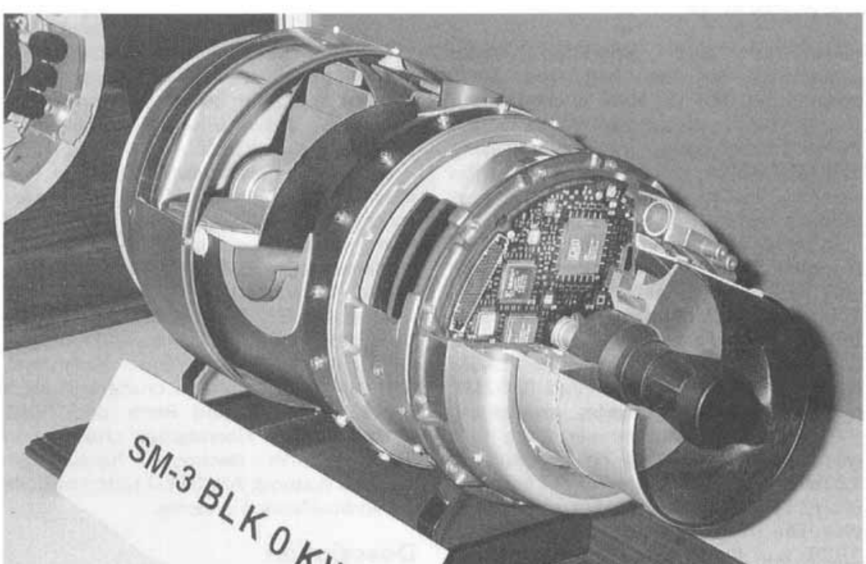
A RIM-66 Standard SM-2MR Mk 26 twin launcher (General Dynamics)

and raked delta fins at the rear. The SM-1MR missiles are 4.48 m long, have a body diameter of 0.34 m and a launch weight of 617 kg. These missiles have a Mk 27 or Mk 56 dual-thrust boost/sustainer motor with a length of 2.75 m and a diameter of 0.34 m. A NSWC Dahlgren Mk 51 continuous rod or Mk 115 HE fragmentation warhead is fitted. Mid-course guidance is command, with a semi-active radar terminal phase. The SM-1MR has a maximum range of 40 km against aircraft targets at medium altitude. The SM-2MR has a length of 4.72 m, a body diameter of 0.34 m, a fin span of 0.92 m and a launch weight of 708 kg. These missiles have either the ARC Mk 56 or Mk 104 motors and either the NSWC Dahlgren Mk 115 or Mk 125 HE fragmentation warheads with the Motorola Mk 45 fuze. Guidance in mid-course is inertial, with monopulse semi-active radar terminal guidance. On the Aegis ships there is also a command link between the missiles and the ship. The SM-2MR has a maximum range of 70 km against aircraft targets at medium altitude, but the block 3A version has an increased range of 80 km. The maximum intercept altitude is 20 km, and the missile has a maximum velocity of just over M3.0.

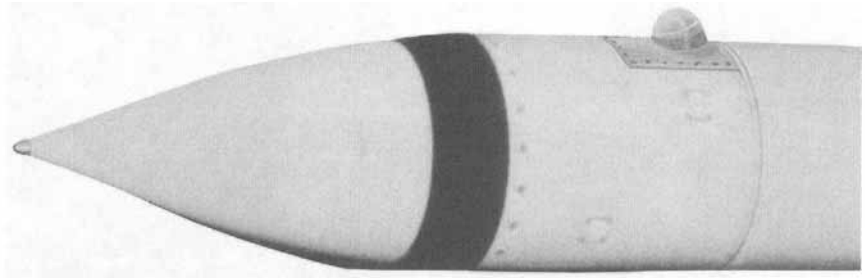
RIM-67 Standard SM-PER missiles have four narrow rectangular wings and four moving clipped and raked delta fins at the rear. In addition, there is a tandem boost motor with four clipped-tip triangular fins. The overall length of missile and booster at launch is 7.98 m, with launch weight increased to 1,509 kg. The warhead is a NSWC Dahlgren Mk 125 HE fragmentation, with a weight of 115 kg. This version has either a Mk 12 or Mk 70 booster motor, which is jettisoned after use. The Mk 12 motor has a length 3.49 m, a diameter of 0.46 m, contains 550 kg of solid propellant and has a total weight of 733 kg. The Mk 70 motor has a length of 3.93 m, a diameter of 0.46 m, contains 682 kg of HTPB solid propellant and has a total weight of 973 kg. These missiles use a Mk 30 or Mk 104 dual-thrust sustainer motor. The Mk 104 motor has a length of 2.88 m, a diameter of 0.34 m, contains 360 kg of TP-H1205/6 solid propellant and has a total weight of 488 kg. The additional booster motor increases the range against high-level aircraft targets out to 120 km. The block 36 version has a dual-mode imaging IR and semi-active radar terminal seeker, with the IIR seeker fitted to the top of the missile just behind the radome section. The IIR seeker is used in particular against sea-skimming cruise missile targets.

The RIM-156A Standard SM-PER block 4 (Aegis ER) version has a Mk 72 boost motor to provide a vertical launch capability with thrust vector control, and is launched from the Mk 41 eight-missile VLS. The Mk 72 boost motor has a length of 1.70 m, a diameter of 0.53 m, contains 468 kg of HTPB-AP solid propellant and has a total weight of 712 kg. This motor has four moveable nozzles. The boost motor burns for 6 seconds and is then jettisoned. The overall length of the SM-2ER block 4 missile with boost motor assembly is reduced to 6.5 m, but with a launch weight of 1,398 kg, an estimated maximum range of 150 km and a maximum intercept altitude of 30 km. This version has the NSWC Dahlgren, 115 kg, Mk 125, HE fragmentation warhead, with a Motorola Mk 45 target detection device (fuse), and uses the ARC Mk 104 dual-thrust sustainer motor. The missile has an S-band command/datalink with the AN/SPY-I radar and the terminal guidance can switch between semi-active radar homing and passive radar homing.

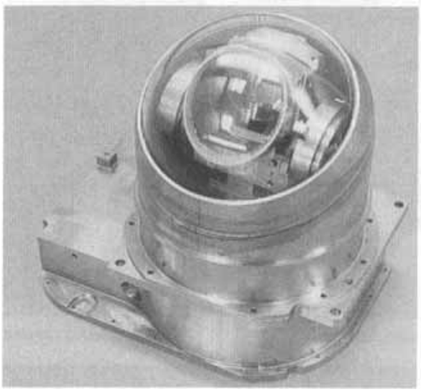
The RIM-156B or Standard SM-2 block 4A missile was being developed and had larger warhead fragments, revised forward and side-looking fuse timing and the addition of the imaging IR/semi-active radar dual-mode seeker used with the block 3B missiles. The SM-2 block 4A missile had a length of 6.55 m, the first-stage assembly was 1.72 m long and had a diameter of 0.53 m, while the second stage had a length of 4.85 m and a diameter of 0.348 m. The fin span was 1.08 m. The missile had a Mk 72 boost motor with four moving nozzles providing thrust vector control, and used the Mk 104 dual-thrust sustainer motor. The semi-active radar seeker was augmented with an active radar capability, which was used to provide a forward looking fuze to initiate the warhead against fast moving ballistic missile targets. The Mk 133 warhead was a modified version of the Mk 125, with larger fragments and a directional focused aiming system controlled by the forward looking fuze. SM-2 block 4A had a weight of 1,500 kg, and was believed to have a maximum range of 200 km. The side-mounted imaging IR seeker has been developed to improve Standard SM-2 block 3B and 4A performance against low-flying cruise missiles with ECM, and for use on block 4A missiles against tactical ballistic missile targets. This seeker is mounted behind the radome and is protected by a cover during missile launch and low-altitude flight. The IIR seeker is cooled by argon gas, which is pressurised in two storage containers by two solid propellant gas generators. The command/



A demonstration model of the kinetic warhead for the SM-3 missile (Duncan Lennox)
2000/0084785



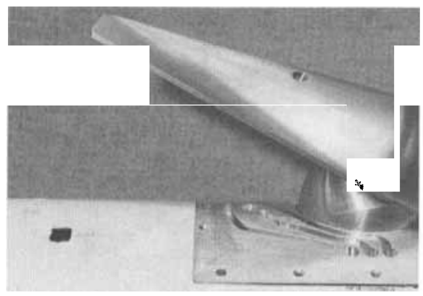
The additional imaging IR sensor fitted to the top of the SM-2ER block 3B and 4A missiles (Raytheon) 0022194



The imaging infra-red sensor dome assembly, fitted to the SM-2ER Block 36 and 4A missiles (Raytheon) 0022192

datalink with the AN/SPY-1 radar operates in both the mid-course and terminal phases of flight. Other changes in this version included improved guidance and control algorithms, improved inertial measurement unit, digital autopilot and improved power generation. A further development, block 4B, was reported in 1996, but no details have been released. The missile modifications were being made together with changes to the Aegis combat system, the AN/SPY-1 and the missile engagement radars, to enable the radars to acquire and track high-altitude fast-moving ballistic missile targets. It has been reported that AN/SPY-1 radars have tracked ballistic missiles at ranges in excess of 500 km. Software upgrades to the Aegis Mk 99 combat system will be to the baseline 6 phase 3 standard, and the radars will have improved capability against closely spaced targets, narrow band endoatmospheric discrimination, and a linear search track processor.

Work on a Lightweight ExoAtmospheric Projectile (LEAP) started in 1985 as part of the former SDIO (now MDA) space-based interceptors programme, but was transferred to the Ground-Based Interceptor (GBI and now GMD) and also to the Standard SM-3 programme in 1992. The BMDO (now MDA) and US Navy amalgamated proposals from two competing LEAP designs using the RIM-156A Standard SM-2ER block 4 missile as the baseline. The missile uses the Mk 72 boost motor assembly as the first stage, and the Mk 104 sustainer motor as the second stage. SM-3 has an additional third stage using a EX-136 solid propellant motor, with thrust vector control and a separate guidance system. A fourth-stage EX-142 LEAP Kinetic Warhead (KW) carries a solid propellant divert and attitude



The IIR sensor dome cover partially removed (Raytheon) 0022193

control system and a LWIR seeker. The IR seeker is protected by a nosecone as the missile flies up through the atmosphere, and the nosecone is then ejected at around 90 km altitude, before the intercept starts. The KW seeker uses a focal plane array of 256 × 256 cadmium mercury telluride detectors operating in the long-wave band, with a range in excess of 300 km. The fourth-stage KW has a weight of around 23 kg, and relies on its kinetic energy at impact with a closing velocity in excess of 4 km/s, together with a cluster of small tungsten rods that are ejected just before impact with the target. The SM-3 missile is expected to have a total weight of 1,505 kg. LEAP designs have been tested on the ground from 1989 and in space from 1992. Since 1996 these studies have also included AIT and EKV kill vehicle options, as well as an adapted THAAD kill vehicle. The proposed Standard SM-3 block 1 missile would have a maximum fly-out velocity of 3.0 to 3.5 km/s, a range of about 1,200 km, and would be able to intercept ballistic missiles at between 70 and 500 km altitude. An improved version of SM-3 is being considered, to be known as block 2, with a higher fly-out velocity of 4.0 to 4.5 km/s, improved lethality, a solid-propellant divert and attitude control system and a two-colour IIR seeker to improve discrimination between warheads, debris and decoys. The SM-3 missile may use an upgraded AN-SPY-I radar, or have a separate high-power discrimination radar based on the Raytheon THAAD-GBR design.

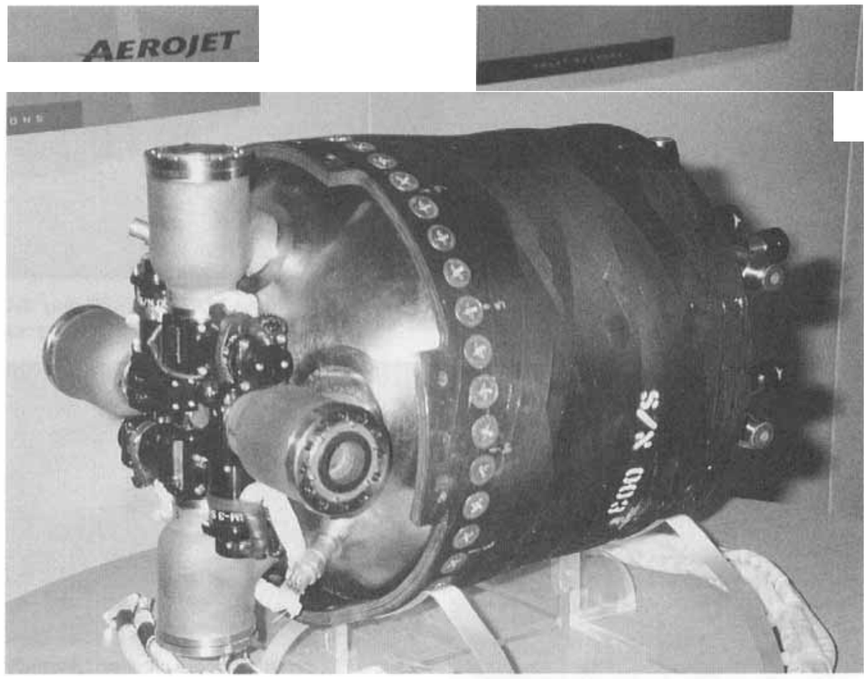
A variety of launcher-handling systems are used with the RIM-66/-67/-156 missile system. The older American ships use the Mk 10 Guided Missile Launch System (GMLS), in which the missiles are stored below decks horizontally in magazine drums each containing 20 missiles. The selected missiles are lifted to the handling area by a hoist, which fits the round to an overhead rail, and then moved forward horizontally through blast doors to the launcher system. Most RIM-66 Standard SM-1 missiles are launched from single missile Mk 13 launchers, while all Standard SM-2 missiles are launched from twin launchers, the Mk 22 or Mk 26 (or later from VLS). The latest launching system is the Mk 41 Vertical Launch System (VLS). The VLS is based on a modular design, the basic unit being a launcher module containing eight missile cells. Standard SM-I/-2 block 2 and block 3 missiles are launched from the tactical module, which is 6.75 m long and weighs 13,595 kg empty. SM-2 block 4 and SM-3 missiles can be launched from the strike module, which is 7.7 m long and weighs 14,545 kg empty. Each of the eight cells in a module is designed to house a missile canister and the system design allows any missile adapted for vertical launch to be fired from any cell. Canisters Mk 13, 15, 22 and 25 are used with SM-2 block 2 and block 3 missiles; these canisters are 5.76 m long with a width of 0.63 m. The canisters with a missile loaded weigh 1,950 kg. Canisters Mk 14 and 21 are used for SM-2 block 4 missiles, have a length of 6.65 m and weigh 2,988 kg with a missile. The missile canister is of corrugated steel construction, serves as the shipping container and also provides the launcher rail for the missile as well as exhaust gas management at launch.

The surveillance radars used with the Standard missile system in US Navy use have been upgraded over the years, but the AN/SPS-40, AN/SPS-48 and AN/SPS-49 are used on the older ships, with the AN/SPY-I used on the Aegis 'Ticonderoga' and 'Arleigh Burke' class ships.

The AN/SPY-1 multifunction S-band phased-array pulse Doppler radar together with the command and decision system Mk 2, Aegis display system Mk 2, weapons control system Mk 8 and fire-control system Mk 99 form the US Navy's AEGIS fleet air defence system. The original radar was designated AN/SPY-1A, but this was improved to AN/SPY-1B, and the latest version is AN/SPY-1D. AN/SPY-1 operates at 2 to 4 GHz (S-band) and in earlier installations the antenna arrays are located with two forward and two aft. Each array measures 3.65 × 3.65 m and contains 4,100 discrete elements controlled by AN/UKY-7 digital computers to produce and steer multiple beams. AN/SPY-1 tracks both the targets and the Standard missiles. For the more recent 'Arleigh Burke' class destroyers with the AN/SPY-1D, the four antenna arrays are mounted on a single deckhouse, one array per side. In 1995 approval was given for a further improvement to the AN/SPY-ID radar, to enhance performance against low-flying missiles when ships are close to land. This upgrade is known as the Littoral Radar or AN/SPY-ID(V).

The engagement radars used by the Standard missile system are the AN/SPQ-9, AN/SPG-51, the AN/SPG-55, AN/SPG-60 and the AN/SPG-62. The AN/SPQ-9 radars are used on the 'California', Virginia' and 'Ticonderoga' class cruisers. The AN/SPG-51 and AN/SPG-60 are used with the 'California' class, AN/SPG-51 with the 'Virginia' class, AN/SPG-55 with the 'Bainbridge' class, AN/SPG-51 with the 'Kidd' class, AN/SPG-60 with the 'Oliver

Mk 104 boost/sustain inotor used with SM-2ER and SM-2 block 4 missiles (Duncan Lennox) 200210132643



A solidpropellant DACS used with SM-3 (Duncan Lennox) 200210132644

A RIM-67 Standard SM-2ER missile at launch from a deck-mounted launcher 0022195

Hazard Parry' class and the AN/SPG-62 with the 'Ticonderoga' and 'Arleigh Burke' class ships.

Operational status

The RIM-66 Standard SM-1MR entered service with the US Navy in 1968 and the SM-2MR entered service in 1978. Both versions have been modified and improved ever since and are still in service. In production in 1998 were SM-1 block 6, 6A and 6B missiles. SM-2 Aegis MR/Tartar missiles block 2, 3, and 3A are also in production. The RIM-67 Standard SM-2ER entered service in 1982 and the latest version, RIM-156A SM-2ER block 4, is in initial production. The first production qualification test was made at White Sands Missile Range in June 1999, and the first at sea firings were made in December 1999. A further order for 43 missiles was placed in April 1999. However, the block 4 missiles will only be fitted to new build ships of 'flight 2' 'Arleigh Burke' class destroyers (DDG51 class), with existing 'Arleigh Burke' destroyers and 'Ticonderoga' cruisers being retrofitted later to accept the block 4 missiles. Block 3B missiles, with the dual-mode seeker, are in initial production and eight missiles were tested in February 1999. An order for 71 new missiles and conversion kits for a further 63 block 3 missiles was placed in April 1999. In 2000, orders were placed for 75 upgrade kits to modify block 2 and 3 missiles to the block 3B standard, and for 89 block 3 and 3A missiles for overseas customers.

In April 2001 orders were placed for 75 block 3B missiles, 80 upgrade kits to modify block 2/3 missiles to block 3B, and for 48 block 3/3A missiles for export. The original Standard missile design was led by General Dynamics (Hughes Missile Systems and now Raytheon), but Raytheon were awarded a second source contract for SM-2MR/ER missiles in 1986 and have prime contractorship of the development of the SM-2ER block 4 improvements programme. In 1995 Hughes and Raytheon announced that they would form a joint company for future Standard missile development and production, to be known as the Standard Missile Company, and in 1997 the two companies missile divisions were merged.

US Navy planned to acquire a theatre ballistic missile defence capability by 2003, known as Navy Area Defence (NAD), which would have been achieved by the RIM-156B Standard SM-2ER block 4A missiles, with a planned total purchase of 1,500 block 4 and block 4A missiles. A research standard block 4A missile successfully intercepted an MGM-52 Lance ballistic missile target at White Sands Missile Range in 1997, and two further successful intercepts were made. LRIP for 22 missiles was authorised in December 2000, but the programme was halted in December 2001

Standard SM-3 missiles were proposed for the US Navy Theatre Wide (now known as SMD) system, with a planned purchase of 500 missiles and an in-service date of 2010, although fast-track procurement plans have also been proposed for an earlier in-service date. Flight tests using a RIM-2 Terrier missile, to demonstrate a Standard SM-3 (NTW) capability, started in 1992.

A series of test flights are in progress, with an initial nine tests including five intercept attempts due to be completed in 2004. These will be followed by six further test flights, with engineering and manufacturing development planned to start in 2004. A final 20 flights are planned during EMD. The early SM-3 tests were made with SM-2ER block 3A missiles. The

Specifications

	RIM-66 SM-1MR	SM-2MR	RIM-67 SM-2ER	SM-2ER block 4
Length	4.48 m	4.72 m	7.98 m	6.5 m (4) and 6.55 m (4A)
Body diameter	0.34 m	0.34 m	0.34 m (booster 0.46 m)	0.34 m (booster 0.53 m)
Launch weight	617 kg	708 kg	1,509 kg	1,398 kg (4) and 1,500 kg (4A)
Warhead	HE fragmentation 115 kg	HE fragmentation 115 kg	HE fragmentation 115 kg	HE fragmentation 115 kg
Guidance	Command and semi-active radar	command, inertial and semi-active radar	command, inertial and semi-active radar	command, inertial and semi-active radar (4) and plus IIR (4A)
Propulsion	solid propellant	solid propellant	solid propellant	solid propellant
Range	40 km	80 km	120 km	150 km (4) and 200 km (4A)

first ship launch for SM-3 was made in September 1999, with CTV-1A launched to an altitude of 56 km to test the capability of the first- and second-stage motors and the missile control system at high altitude. The next flight test, FTR-1, was made in July 2000 and used the third-stage motor, but this was a failure and a second test using FTR-1A was made in January 2001. The fourth test, FTR-2 (or FM-2). was made in January 2002, and used a KW with a solid propellant DACS. A successful intercept was made with an Aries ballistic missile target. An initial operating capability is expected to be achieved by around 2008, with up to four ships equipped with a total of 80 missiles. A Co-operative Engagement Capability (CEC) is being developed to link ballistic missile tracking from Aegis, Patriot and HAWK radars together with a data fusion system to allow an integrated ship/land tactical ABM system to be developed.

Three tests were made in 1997 and 1998 for the Land Attack Standard Missile (LASM) using the existing Mk 125 warhead. The US Navy plans to modify up to 800 SM-2 block 2 and 3 missiles to this standard with an in-service date of 2004.

It is expected that a total of about 25,000 Standard missiles will be built, with the production lines remaining open until 2006 or later. Exports of SM-1 Standard missiles have been reported to Australia, Canada, France, Germany, Greece, Iran, Italy. Japan, South Korea, Netherlands, Pakistan, Poland, Spain, Taiwan and United Arab Emirates. Exports of SM-2 missiles have been made to Canada, Japan and Taiwan. The Mk 41 VLS is to be built under licence in Japan, by Mitsubishi Heavy Industries. In 2000, a joint three year feasibility study was started by Germany and Netherlands to examine fitting SM-2 block 4A missiles into their F124 and LCF sir defence frigates. Germany, Netherlands and Spain are also reported to be examining the possibility of joint production and maintenance of SM-2 block 3 and 4 missiles in Europe.

Associated radars
Acquisition radars: AN/SPY-1 Aegis
Frequency: 2-4 GHz (S band)
Peak power: n/k
Range: n/k

Engagement radars: AN/SPG-51/55
Frequency: 4-6 GHz (C-band) and 8-10 GHz (X-band)
Peak power: n/k
Range: 50 km

AN/SPG-60/62
Frequency: 8-10 GHz (X-band)
Peak power: 5.5 kW
Range: 110 km

AN/SPQ-9
Frequency: 8-12 GHz (X-bands)
Peak power: n/k
Range: 35 km

Contractor

Raytheon Missile Systems, Tucson, Arizona (prime contractor).

Theatre High-Altitude Area Defence

Two standardised interface command post system shelters on HMMWV comprising the THAAD tactical operations station and launch control station

Type

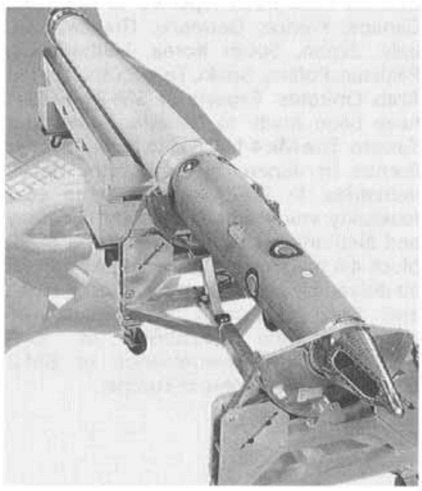
Medium-range, ground-based, solid-propellant, theatre defence missile.

Development

Studies began in 1990 for a Theatre High-Altitude Area Defence (THAAD) missile system, to intercept tactical/theatre ballistic missiles or RVs, providing an area defence coverage. It is planned that THAAD will provide the upper layer of defence above existing Patriot and HAWK surface-to-air missile defence systems, intercepting ballistic missiles in the high endoatmosphere and exoatmosphere (over 120 km altitude). In 1992 Lockheed Martin was awarded a demonstration/ validation contract for THAAD and Raytheon for the associated THAAD Ground-Based Radar. Discussions between the US Army and US Navy in 1994 considered the merits of developing a common ground-mobile and shipborne system, using a modified THAAD missile with a RIM-67 Standard Mk 72 boost motor assembly launched from the Mk 41 vertical launch system. The US Navy preferred the RIM-156 Standard SM-2 block 4 missile with a third-stage motor and a Lightweight Exo-Atmospheric Projectile (LEAP) kill warhead added, known as SM-3 or Navy Theatre Wide, and now known as Sea-based Mid-course Defense (SMD).

The THAAD system will comprise wheeled transporter-erector-launcher vehicles, a mobile surveillance, acquisition and tracking radar (THAAD-GBR) and a battle management and communications system. It is planned that the THAAD system will interface with the existing Patriot, HAWK and Standard/Aegis systems and share common target data with them. Early warning of ballistic missile launches could be provided for the THAAD system from DSP satellites or airborne early warning aircraft, with target co-ordinates being passed to the THAAD-GBR.

The project definition and risk reduction phase was terminated early after two successful intercepts in June and August 1999, and the programme moved into the first phase of engineering and manufacturing development in June 2000. A new IIR seeker was included in the last four flight tests, but major design changes will be made before the next flight test programme begins. A new mission computer, a reduced number of parts, increased divert thrust and fuel, improved TVC and a new cylindrical canister are planned, together with a significant reduction in the unit production cost. The minimum intercept altitude is to be increased, believed to be to around 40 km. It is expected that the improvements will be divided into block 1 (configuration 1) and block 2 (configuration 2) increments, with block 2 providing an improved performance against decoys and debris. The second phase of EMD is expected to start in 2003, and the first flight tests are planned to start in 2004. All major components of the THAAD system are to be C-141 aircraft transportable.



An early THAAD airframe, showing the nose seeker assembly casting, kinetic kill vehicle body and (left rear) the motor assembly

Diagram of the THAAD missile

Description

The THAAD missile is a two-stage system, with the second stage a separating kinetic kill vehicle, with a total launch weight of 600 kg. The HTPB solid-propellant boost motor assembly has a thrust vector control system and a deployable flare skirt at the rear end to provide additional missile stability in flight. THAAD is hot launched from its canister. The missile is expected to have a maximum velocity of around 2.5 km/s, followed by a kinetic energy kill by direct impact on the target. The missile has no wings or fins, and has a total length of 6.17 m, with a body diameter of 0.34 m. The kill vehicle has a length of 2.32 m and a maximum body diameter of 0.37 m. Guidance in mid-course is believed to include inertial, GPS and command updates. Terminal-guidance in the earlier kinetic kill vehicles used a Lockheed Martin gimbal-mounted platinum silicide focal plane multicolour IIR seeker, but the later kill vehicles used an indium antimonide 256 × 256 element focal plane array also used in the Israeli Arrow and US Standard SM-2 block 3B missiles. The seeker is inertially stabilised, gas cooled and has a filter switch that sets the gain for either endo-atmospheric or exo-atmospheric intercepts. The kill vehicle will be provided with a predicted intercept point and target object map prior to launch. The intercept point and target object map are then updated during the missile flight by commands from the THAAD-GBR, until the terminal guidance phase starts. The kinetic kill vehicle is protected by a conical shroud that opens in two halves during flight, allowing protection of the uncooled sapphire IR seeker window from aerodynamic heating at low altitudes. The kill vehicle has a Boeing Rocketdyne divert and attitude control system using liquid bi-propellants, with six thrusters for roll, pitch and yaw control, and four divert thrusters. THAAD is expected to have a maximum

A trials THAAD Ground-Based Radar vehicle complex; front left is the antenna, mid-left the electronics unit. upper left the operator control centre vehicle, mid-right the cooling unit and far right the power supply unit (Raytheon) 0022201

range of about 250 km, with the ability to intercept at altitudes from around 40 km up to 150 km.

The mobile THAAD transporter-erector-launcher vehicle will use the Oshkosh Truck M1075 US Army Palletized Loading System (PLS), to increase reload flexibility in the field. This TEL is a wheeled 4 × 6 vehicle, initially carrying six missile canisters, but with the capability to carry up to 10, and is C-141 transportable. The missile canisters are raised to about 75" elevation for launch. The PLS will enable a complete reload to be accomplished in 30 minutes. The TEL is fitted with GPS and has a length of 12.0m, a height of 3.25m and a loaded weight of 40,000kg. Eight missile canisters are loaded together onto a pallet for carriage in a C-141 aircraft.

A companion programme to develop a combined surveillance/engagement radar, known as the THAAD Ground-Based Radar, uses an 8 to 12 GHz (X-band) single face phased-array radar about 12.5m long, mounted on a Heavy Expanded Mobile Tactical Truck and capable of being transported in a C-130 Hercules aircraft. The radar is non-rotating and has a 120° field of view. The radar complex has five vehicles; the operator control centre, antenna, electronics unit, power supply and cooling trailers. THAAD-GBR will provide uplink commands for the THAAD missiles to indicate the expected impact point and send target object maps to these missiles before the IR seeker starts to search for the designated target. The radar has an aperture of 9.2m², a range of about 1,000km and has 25,344 solid-state transceiver modules each with a power of 6 to 8 W. THAAD-GBR is powered by a 1.1 MW advanced tactical generator powered by a diesel engine. The battle management and communications system is distributed between seven vehicle-mounted shelters, comprising a tactical operations centre, a communications relay and a sensor system interface. These standardised interface command post system shelters are mounted on HMMWV vehicles comprising the Tactical Operations Station (TOS) and Launch Control Station (LCS). Various software configurations are then used to perform the different THAAD systems functions within the vehicles. The THAAD system will be integrated with the US Navy Aegis weapon system so that the Cooperative Engagement Capability (CEC) can be used to cue the THAAD-GBR from AN/SPY-1 radar tracks, increasing the area defended by THAAD.

An Oshkosh Truck M1075 Palletized Load System THAAD transporter-erector-launcher vehicle

The THAAD missile during the third test flight, October 7995 (Lockheed Martin)

Operational status

Contractor studies for THAAD started in 1990, with concept definition in 1991. A four-year demonstration/validation programme started in 1992 on the THAAD system, with up to 14 flight tests originally scheduled for 1995-97, but later extended into 1999. The first flight test was successfully completed in April 1995. The first launch from the Palletized Loading System TEL was made in March 1996 and the first using the THAAD-GBR directly in the engagement made in March 1997. By April 1999 nine test flights had been made, three tests without intercepts being attempted and with the last six attempted intercepts all failing to complete a successful interception. The ninth flight test, made in March 1999, used the new InSb seeker for the first time, although the same seeker was used on the eighth flight which was destroyed shortly after launch. The tenth and eleventh flight tests were made in June and August 1999, and both were successful and the flight test programme was terminated early to move forward into engineering and manufacturing development with a new build standard missile incorporating many improvements. Two development THAAD-GBR were delivered by Raytheon in 1996, and have been tested at the Kwajalain Pacific Test Range and at White Sands against closely spaced re-entry objects and during subsequent THAAD flight tests. The first THAAD battery with 81 soldiers was activated at Fort Bliss in June 1995, as part of the First Battallion of the Sixth Air Defense Artillery.

Phase 1 of the engineering and manufacturing development programme for the redesigned missile started in June 2000, and phase 2 is planned to start in 2003, with the first flight tests starting in 2004. Five successful intercepts of the

new missile have been described as the requirement for low-rate initial production to be authorised. Six development and eight operational tests are planned, to be followed by some 20 to 25 flight tests for operational evaluation up to 2009. The short-range flight tests will be conducted at the White Sands Missile Range, and the full-range flight tests at the Kwajalein Range in the south Pacific. In August 2000, orders were placed for 30 missiles, with an option for 14 more, seven launch vehicles, three THAAD-GBR. and six BMC3 shelter groups. A total service inventory of 76 launchers, 10 THAAD-GBRs, 38 TOS/LCS, 68 systems support groups and 1,250 missiles was planned, but will probably be adjusted. The US Army plans to field *two* THAAD battalions each with four batteries. Each battery will have one THAAD-GBR and up to nine launchers, with a total of 135 personnel. Full-rate production is planned to start in 2007, with final assembly and test of the missiles at Lockheed Martin's plant at Troy, Alabama. An in-service date of 2008 is expected for the initial deliveries of the block 1 system, believed to be 16 missiles, two launchers and one radar. The block 2 capability is expected to enter service between 2012 and 2015.


A THAAD-GBR antenna unit, a single face phased-array assembly (Raytheon) 0022200

Specifications

Length: 6.17 m
Body diameter: 0.34 m, motor assembly; 0.37 m, kill vehicle
Launch weight: 600 kg
Warhead: Direct impact kill vehicle
Guidance: Inertial, GPS, command with IR
Propulsion: Solid propellant with liquid propellant kill vehicle
Range: 250 km

Surveillance/Engagement radar: THAAD-GBR
Frequency: 8-12 GHz (X-band)
Peak power: n/k
Range: 1,000 km

Contractors

Lockheed Martin Missiles and Fire Control, Dallas, Texas (THAAD missile and system).
Raytheon Systems Company, Bedford, Massachusetts (THAAD-GBR).

YMGM-1 57 (EFOG-M)

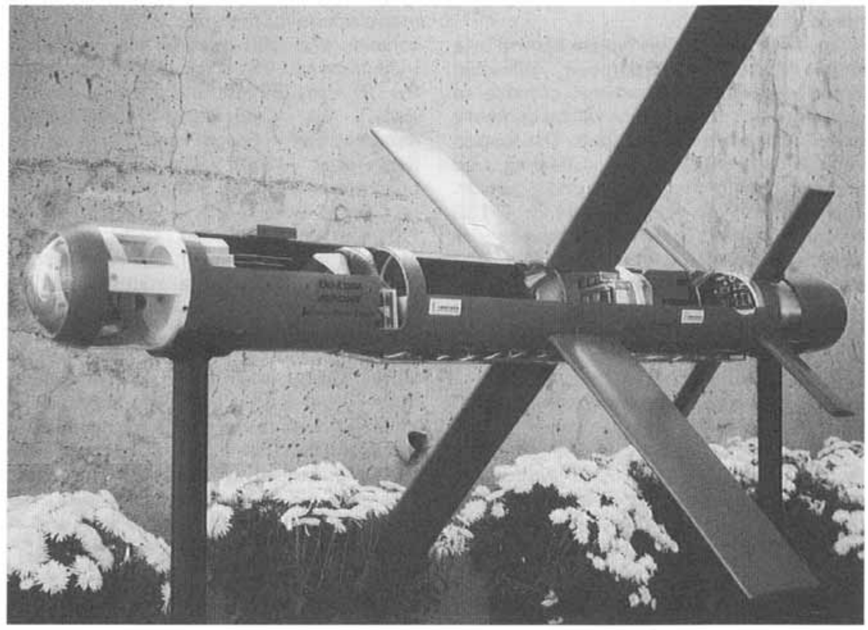
Type

Short-range, ground-launched, solid-propellant, theatre defence and surface-to-surface missile.

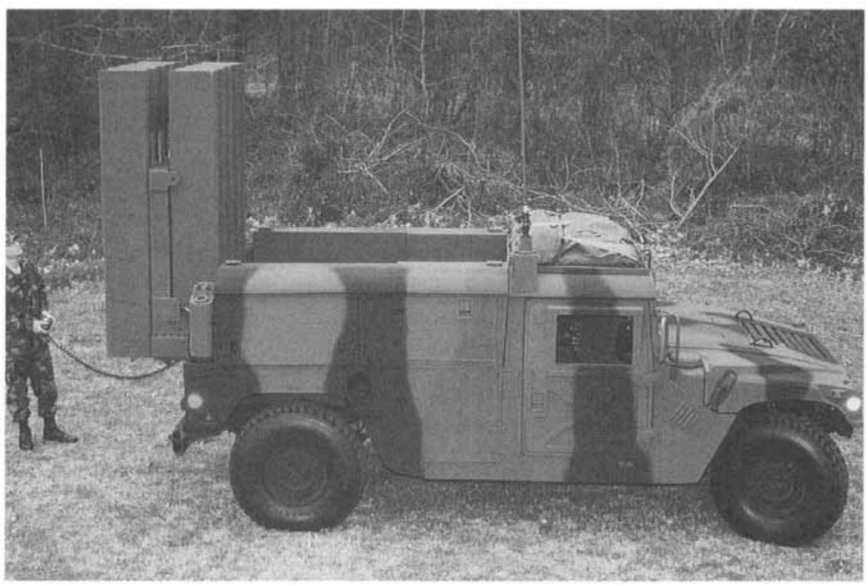
Development

Development started in 1979 with the US Army investigating the use of fibre optic guidance for their N-LOS (Non-Line Of Sight) element of the Forward Area Air Defence System (FAADS) programme. The research programme through the early stages was in-house by the US Army Missile Command (MICOM), (now Army Aviation and Missile Command) at its Research, Development and Engineering (RD&E) Centre, where it was known as the Fibre Optic Guided Missile (FOG-M). Full-scale development was awarded to Boeing Aerospace and Hughes (now Raytheon) in December 1988 and the programme was scheduled to last 42 months. The US Army originally intended to field N-LOS (FOG-M) in two versions: an interim model fitted with a high definition TV camera, and a 'fully compliant' version with an Imaging Infra-Red (IIR) sensor. The missile was to be powered by a small turbojet engine. The FOG-M programme was terminated in 1990, but was revived in 1992 as NLOS-CA (Combined Arms).
In 1994 the US Army awarded a six-year advanced technology demonstrator programme contract to Raytheon, to develop an Enhanced Fibre Optic Guided Missile (EFOG-M) and to complete 14 test flights. EFOG-M was required for use in rapid force projection scenarios, with a dual capability against armoured vehicles, selected ground targets, UAVs and helicopters out to a range of about 15 km. The missile system had the US designator YMGM-157. In 1998, it was reported that the US Army were reconsidering a turbojet powered version, called the Tele Operated Precision Kill and Targeting (TOPKAT) missile, with a range increased to 30 km, for real-time reconnaissance and battle damage assessment tasks. Another proposal was initially called Longfog, but is now called the Army Aviation and Missile Command Multi-mode Airframe Technology (AMCOMMAT) missile, with a range of 100 km and possibly using a dual-mode, fibre optic cable capable of handling both radar and IIR images from two seekers.

In 2000, the US Army proposed a further version, known as the Precision Kill And Targeting (PKAT) missile, which would use the EFOG-M airframe and engine, but would replace the fibre optic cable with a radio command link. The PKAT version would have a range of around 30 km, and could be launched from standard MLRS canisters on the MLRS launch vehicle, or from HMMWV.



A sectioned EFOG-M displayed in Washington DC in October 7994 (Duncan Lennox)



A proposed HMMWV launch vehicle configuration for the EFOG-M. with eight missile canisters raised to the vertical for launch

Description

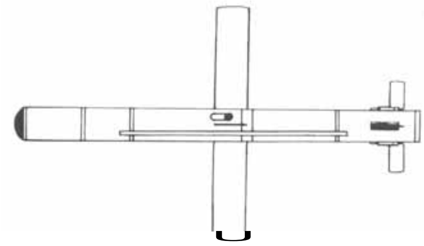
EFOG-M is reasonably similar to the European Polyphem missile programme. It has four fixed, long slender rectangular wings at mid-body and four small rectangular moving control fins at the rear. The wings and rear fins are folded while the missile is in the launch tube and unfold at launch. The missile is 1.94 m long, has a body diameter of 0.17 m and a wing span of 1.14 m. The launch weight is 51.3 kg. The missile has an IMU/GPS mid-course navigation system with an imaging IR seeker for the terminal phase, which transmits video images to the operator via a 240 µm diameter, two-way fibre optic cable that pays out behind the missile. The IIR seeker has a focal-plane array of 640×480 platinum silicide detector elements operating in the 3 to 5 µm band, providing a TV-compatible picture. Guidance is semi-autonomous or direct, with the gunner in the launch vehicle designating the selected target using a joystick. EFOG-M has solid-propellant boost and sustainer motors, giving the missile a maximum velocity of 100 m/s. The missile is stored in a canister, with a loaded canister weighing 78.5 kg, and hot launched vertically from the HMMWV launch vehicle. After launch, the missile climbs to around 300 m altitude, then levels off and follows the selected way points to the target area. The IIR seeker can be used to search for and lock-on to both fixed and moving targets. The missile can be pre-programmed to take a particular route, or the operator can steer the missile and move the seeker with a joystick to examine targets of interest en route. When attacking ground targets the missile flies a constant altitude mid-course, but the operator then allocates the target and selects the aim point using the seeker and the joystick; the missile then dives on its target for maximum warhead effect. The warhead is an HE shaped charge, although

an explosively formed penetrator warhead has been reported for use against armoured vehicles. EFOG-M has a maximum range of 15 km and a minimum range of 1 km.

The EFOG-M missiles will be carried by a High Mobility Multipurpose Wheeled Vehicle (HMMWV) (Humvee) capable of carrying eight missiles that will be vertically launched from their canisters. The loaded vehicle has a weight of 4,540 kg and carries a crew of two, a driver and a gunner. The HMMWV is transportable in C-130 Hercules aircraft. There is a Platoon Leader Vehicle (PLV), also using a HMMWV, that carries a crew of two and provides the co-ordinated mission planning for the individual fire units.

Operational status

The N-LOS programme was two years into full-scale development with several successful firings already carried out but, in April 1990, the US DoD cancelled production funding for FY90-94 and in December 1990 the development programme was halted. However, in 1992 the US Army decided to continue studies, as the NLOS-CA programme. In 1994 the EFOG-M programme advanced technology demonstrator phase started, with a plan to manufacture 12 fire units, 3 platoon leader vehicles and 300 missiles for evaluation trials between 1997 and 2001. However, the US Army did not fund the programme, and the advanced technology demonstrator programme ended in September 1999. The demonstrator programme included 9 flight trials, the first test firing was made in 1997 and the fifth test, in September 1998, was the first to use the IIR seeker. The sixth test, in January 1999, was a night flight to a range of 6 km. The seventh test, in April 1999, was a night flight out to a range of 11 km. The eighth flight was made in June 1999, and the ninth and final flight was made in September 1999 against a tank target at 6.2 km range. The last seven test flights were all successful. In 2000, a further version was proposed, known as PKAT, using a radio command link in place of the fibre optic link used in EFOG-M.



***Line diagram of** EFOG-M* 0054261

Specifications

Length: 1.94 m
Body diameter: 0.17 m
Launch weight: 51.3 kg
Warhead: HE shaped charge
Guidance: Imaging IR with fibre optic link
Propulsion: Solid propellant
Range: 15 km

Contractor

Raytheon Missile Systems, Tucson, Arizona (prime contractor).

ARMS CONTROL TREATIES

ARMS CONTROL TREATIES

Background, Evolution and Key elements

Introduction

The arms control process is basically a means to improve communications and political relationships between the nations of the world. Supporters of the process see this as reducing the risk of war, reducing the resources devoted to preparations in case of war, and reducing the damage of war should it occur. Skeptics of the process see arms control providing a false sense of security, believing that individual nations will provoke a confrontation whenever the leadership perceives that it will gain an advantage. In general, policy makers prefer the arms control process, as it is seen as being less expensive in the short term than military funding. On the other hand, military leaders tend to dislike the arms control process as they see it as an undesirable political restriction on their programmes.

Once the means of assessing the strategic nuclear missile threat arrived through the use of satellite photography, the strategic weapons forces of the major powers became, and have remained, the centre of political interest and control.

This is of great value to the commentator since the making of treaties is essentially a public process and the thinking, intentions, capabilities and strategies of negotiating nations is revealed in the negotiating process. Furthermore, since a treaty can be expected to hold good for 25 to 30 years, the long-term military planning of the signatories is cast within the agreed terms, or more precisely, within the negotiating record, for there lie the conditions that were not acceptable as well as those that were. The record is more revealing than the treaty itself, as it indicates the intentions a party sought to protect, capabilities a party sought to exclude from others and, most importantly, power a party sought not to share.

The earlier arms control treaties, such as the Strategic Arms Limitation Treaty (SALT 1), the Anti-Ballistic Missile Treaty (ABM), the Intermediate Nuclear Forces Treaty (INF) and the Strategic Arms Reduction Treaty 1 (START 1) were bilateral treaties between the USA and the former USSR. Following the break-up of the Soviet Union, treaties are now more general, and will as a result be more difficult to negotiate and verify afterwards. The Treaty between the USA and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms (START 2). signed in January 1993 follows the lines of START 1, but the Chemical Weapons Convention, also signed in January 1993 and the Comprehensive Test Ban Treaty, signed in September 1996, were signed by over 100 nations at the outset.

In 1987, a new form of treaty appeared, known as the Missile Technology Control Regime (MTCR), whereby individual nations agreed to voluntarily restrict the export of nuclear capable ballistic or cruise missiles and their component technologies. This regime is not a treaty, and has been difficult to implement. The MTCR was updated in 1993 to include components for biological or chemical warheads. The end of the Cold War led to the closing down of the Coordinating Committee for Multilateral Export Controls (COCOM) in 1994, originally aimed at restricting export of military technologies to the former USSR or Warsaw Pact countries. This has now been replaced by the December 1995 Wassenaar Agreement, signed to date by 33 countries, which includes conventional weapons as well as warheads of mass destruction together with a long list of possible dual-use equipments such as machine tools and computers. The agreement requires each nation to have fully effective export controls and to notify each other of all exports to non-member nations. The Wassenaar Agreement is not directed against any specific countries or regions, but does concentrate controls against nations considered to be dangers to regional stability.

All of these features have emerged from the treaties surrounding strategic weapons, and indeed continue to do so with the result that it is of value to examine the treaty process as it has evolved. This is done in the following pages, which also contain summaries of the principal provisions of each of the treaties discussed; the complete texts of these treaties form the entries to this section.

The Limited Test Ban Treaty 119631

The full 'title of this treaty is the 'Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water'.

The LTBT is an interesting treaty because it was the first of many attempts by the major powers to reach an agreement on the limitation and control of nuclear weapons. This provided the first indications of the fundamental differences between the Western and Eastern outlook on such matters. The new weapons that had emerged from the Second World War were able, for the first time, to threaten the heartland of a nation with devastation; that is to say, they were truly strategic and as such were wholly different from those that had gone before. The negotiations brought out the significant differences in attitude and outlook between the former Soviet Union and the West in a variety of aspects. At the outset, the treaty had been intended to ban nuclear weapon testing altogether, but this foundered on issues of trust and verification. Initially, the former Soviet Union was of the view that inspection was unnecessary, as exposure of clandestine testing would attract world condemnation; given prior political events in other areas, the USA was not convinced that this would have much deterrent value. Thus the principle of inspection was introduced and a Conference of Experts convened to determine the requirements for adequate monitoring of the treaty. The Conference proposals, which comprised an extensive network of manned stations (180 on land and 10 at sea), were unacceptable to the former Soviet Union. They considered on-site inspection overly intrusive and their own counter proposals, for unmanned stations or a very small number of challenge inspections, which could be subject to Russian veto, were found equally unacceptable to the West. The stalemate was broken by the former Soviet Union with the proposal for a limited ban, which excluded underground testing. This removed the concerns relating to radioactive hazards, which had been the original motivation for a treaty, and at the same time removed the need for comprehensive monitoring. The issues that emerged in these negotiations have continued to reverberate through all subsequent treaty subjects, with the parties gradually learning how to meet their separate concerns. By 1996, with the drafting of the CTBT, it had been accepted by the Russian Federation that a network of manned ground stations would be acceptable to monitor compliance with this new treaty. However, with the rejection by the US Senate in 1999 to ratification of the CTBT, the attitudes had turned full circle between the two nations.

It is of interest to note that neither France nor China were signatories to the Limited Test Ban Treaty in 1963.

The key treaty elements are:

- To limit the spread of radioactive material from nuclear tests.
- To confine nuclear tests to underground.

The September 1996 draft Comprehensive Test Ban Treaty will replace the Limited Test Ban Treaty, when the former has been ratified.

The Outer Space Treaty (1 9671

The full title of this treaty is the 'Treaty on the Principles Governing the Activities in the Exploration and the Uses of Outer Space, Including the Moon and other Celestial Bodies'.

Its purpose was to limit the militarisation of space and the moon, both of which were becoming accessible with the development of rocketry. In particular, the treaty reflected the concern that nuclear weapons would be a part of such developments. The treaty was rapidly agreed, with little or no argument, but this was largely due to the absence of definitions for the constraints that it imposed. It does not, for example, define 'weapons of mass destruction', 'peaceful purposes' or 'outer space'. As it happens, this shortcoming has not led to any threat to either party, and hence has caused no concern nor dispute, despite the fact that the space activities of the major powers have been predominantly military. As the negotiations of later treaties illustrate, where there is an implicit threat, adequate definition of terms must be added to the list of essentials, for a treaty that is going to be approved and acquire wide acceptance.

The key treaty elements are:
- Nuclear weapons will not be placed in earth orbit, on the moon, or in outer space.
- Limitation of the use of the moon and other celestial bodies to peaceful purposes.

The Non-Proliferation Treaty (1970)

The full title of this treaty is the 'Treaty on the Non-Proliferation of Nuclear Weapons'.

Its primary purpose was to limit the formation of multinational nuclear forces and to prevent the uncontrolled spread of nuclear weapons. The former Soviet Union's concern was with both of these issues, but primarily with the threat posed by the Western Multilateral Nuclear Force and the British Atlantic Nuclear Force proposals. The Western concerns extended to the effects of such a treaty on their commercialisation of nuclear power, and the foreign basing of nuclear weapons. Once suitable safeguards had been set up to cover these points the treaty was agreed. It is only in retrospect that this treaty has become the cornerstone of the nuclear disarmament lobby throughout the world, with particular emphasis within the nuclear states themselves. The later review conferences have enshrined the principle that nuclear weapons will be totally eliminated, something that the present nuclear states do not consider as practicable or advisable.

The key treaty elements are:

To prevent the spread of nuclear weapons to nations not already possessing them.
- To provide international safeguards relating to the movement of nuclear material and weapons.
- To promote the peaceful uses of nuclear energy.
- To pursue negotiations for general and complete nuclear disarmament.

The fifth NPT review conference in May 1995 agreed to an indefinite extension of the Treaty and to the introduction of no notice inspections of facilities and records by the International Atomic Energy Authority. In addition, it was agreed that work should continue towards a Comprehensive Test Ban Treaty (CTBT), a stop to the production of fissile materials, the establishment of nuclear-free zones, and unimpeded transfers of peaceful nuclear technologies. The sixth review conference was held in April 2000 and, despite grave concerns, was judged by some as a success. The main issues highlighted at the fifth conference had not progressed, the ratification of the CTBT had stalled, the Fissile Material Cut-off Treaty (FMCT) had not started, and the nuclear tests by India and Pakistan in 1998 had indicated a clear proliferation of nuclear weapons that could not be ignored. Success was claimed due to an agreed set of words in the final statement, which committed the five nuclear states (China, France, Russian Federation, UK and USA) to an unequivocal undertaking to accomplish the total elimination of their nuclear arsenals. This needs to be seen though in the light of a revised April 1999 NATO doctrine, which stated that nuclear weapons make a unique contribution in rendering the risks of aggression against the alliance incalculable and unacceptable. The five nuclear states did not agree to any timetable or agenda for the elimination of their nuclear weapons, and the statement has been described as simply an aspiration of the non-nuclear states. The NPT now has 187 nations as signatories, with four nations absent (Cuba, India, Israel and Pakistan). India, Israel and Pakistan are believed to possess nuclear weapons, but are not being offered membership as nuclear states, only being offered membership as non-nuclear states. This presents an impasse for these states. Russia and China protested about the US plans to deploy a national missile defence system, contrary to the 1972 ABM treaty, but the final statement simply repeated previous support for the ABM Treaty without discussing the merits of linking offensive and defensive capabilities into any new treaty process.

The Seabed Treaty (1971)

The purpose of this treaty was to continue to limit the spread of nuclear weapons under the sea, in the same way that the Outer Space Treaty (1967) limited weapons in space. Both the USA and former USSR were concerned that the other was planning to place nuclear mines in known submarine zones, for detonation in wartime and both nations wished to ban any such options.

The key treaty elements are:
- To prevent nuclear weapons being placed on or under the seabed.
- To ensure that any facilities on the seabed, outside the 12 mile coastal zone, would be open for inspection.

Risk Reduction Measures (1971)

This agreement was specifically aimed at reducing the risk of accidental or unauthorised launches of nuclear weapons and the consequent outbreak of an unintended war.

The key agreement elements are:
- To maintain and improve organisational and technical arrangements to guard against accidental or unauthorised use of nuclear weapons.
- To notify each other immediately in the event of an accidental or unauthorised launch.
- To attempt to destroy or render harmless any weapon that has been launched accidentally or unauthorised.
- To notify each other in advance of planned missile launches if these are directed towards the other nation.

The SALT 1 Treaty (1972)

This treaty was the outcome of the first set of Strategic Arms Limitation Talks, which later became known as SALT 1.

The backdrop to this treaty was a combination of the proliferation of strategic ballistic missiles by both the former Soviet Union and the USA, the growth of confidence in anti-missile capabilities during the 1950s. and the USA's concern at the belligerence of the former Soviet Union in the aftermath of the Cuba crisis of 1962.

The purpose of the USA at the outset of negotiations was to limit both the physical size of strategic missiles and their proliferation; the former Soviet Union, for its part, was on the threshold of deploying the generation of missiles initiated by the Cuba affair, and concerned by the USA's technological lead. There were no limits on warhead numbers and events over the following years have confirmed that apart from establishing upper limits on strategic delivery vehicles (Strategic Nuclear Delivery Vehicles, or SNDVs), little of importance was achieved by the SALT 1 Treaty.

The principal purpose of the SALT 1 Treaty was to prevent further increases in missile deployment and hence the agreement was to freeze the deployments at the 1972 levels. The 1974 protocol clarified the agreement through the provision of limits on submarine-based missiles.

Thus, the treaty provided for:
- Land-based missiles; USA - 1,054 missile launchers, USSR - 1,618 launchers.
- Sea-based missiles; USA - 710 launchers on 44 boats, USSR - 950 launchers on 62 boats.
- Agreement not to convert launchers for light ICBMs into launchers for heavy ICBMs.
- In the process of silo modernisation the dimensions of silos would not be significantly increased, a term later agreed to mean a limitation of 10 to 15 per cent in dimensions.

The 1972/4 ABM Treaty

The full title of this treaty is the 'Treaty between the USA and the USSR on the Limitation of Anti-Ballistic Missile Systems'.

This treaty was an integral part of the SALT 1 Treaty, and reflects the joint concern the major powers had for both aspects of the missile threat. They sought essentially to stabilise the situation by allowing both types of force to co-exist, at the same time preventing either the strategic missile or the defence against it, to destabilise their individual positions. The 1972 Treaty, modified by the 1974 Protocol, allowed for a single defence system against the strategic missile threat to be deployed in the two signatory countries, the USA and the former USSR. The freedoms allowed by the treaty varied depending on whether the defence was for the national capital or a missile field. The treaty specifically excluded any national missile defence, meaning the defence of the complete homeland. Agreement was reached in 1997 to amend the states parties to the ABM Treaty to include Belarus, Kazakhstan, Russian Federation, Ukraine and USA, and to define the difference between theatre missile defences and ABM systems, but this has not been ratified by the USA.

The key elements of the treaty are:
- For a site defending the national capital, within a radius of 150 km centred on the national capital, the launcher numbers are limited to 100 and missile numbers at launch sites to 100. The limitation of ABM radar complexes to six, of no more than 3 km in radius.
- For a site defending a missile field, within a 150 km radius of the centre of an ICBM complex, the same 100

missile and 100 launcher constraints, limitation of large phased-array radars at the sites to two and limitation of smaller radars at the sites to 18.
- The banning of mobile ABM components and the placement of components at sea or in space.
- Constraints on the introduction of new technologies for the ABM role, until they have been the subject of discussions.

In effect, this treaty created the principle of Mutually Assured Destruction (MAD) by limiting strategic ballistic missile defences, although it must be remembered that with over 2,000 ballistic missiles on each side, the cost of an effective defence in 1972 would have been impossible anyway. The ABM Treaty has been under increasing pressure, as the strategic nuclear ballistic missile numbers reduce due to the START process, and as the associated cost of ownership becomes unacceptable, following the end of the Cold War. In addition, the possible threat to the Russian Federation and USA from other nations is seen to be increasing. The result has been the 1997 agreement on theatre missile defence, to agree a definition that allows defence against ballistic missiles with ranges up to 3,500 km. However, there are four key points to the present debate on the future of the ABM Treaty. The principle of MAD seems totally inappropriate for two nations seeking to forge a new relationship of friendship and mutual respect. The proposal to increase the signatories to include Belarus, Kazakhstan and Ukraine, whom have no strategic ballistic missiles, seems pointless and counter-productive. The Russian Federation is concerned about the possible future development of US space-based ABM components, such as the proposed SBIRS low and space-based laser programmes, as these could provide the USA with a considerable operational advantage. As the US National Missile Defence (NMD) programme approached an initial deployment decision the opposition from other nations has increased. There are also deep divisions within the USA, with supporters for both NMD and the preservation of the ABM treaty using distorted and biased arguments. China feels that it is being left out of the discussions, and yet has a genuine concern as the nuclear forces of both the Russian Federation and the USA might at some time threaten their region. China and Russia fear that the initial deployment plans of the USA will be improved with time until the US has a reasonable defence of the whole of its homeland, at which point the nuclear deterrent forces of these two countries might be ineffective against a first strike. France and the UK fear that a unilateral departure from the ABM treaty by the USA would destabilise world arms control negotiations, and prompt both China and Russia to increase their strategic nuclear deterrent forces to be able to overcome any US NMD system.

In December 2001 the USA served notice on the Russian Federation that the USA would withdraw from the treaty in six months time, a term of notice required by the treaty articles.

Biological and Toxin Weapons Convention (1972)

The full title of this convention is the 'Convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and their destruction'.

This convention was established in 1972 to achieve effective progress towards the elimination of biological and toxin weapons following on from the 'Protocol for the prohibition of the use in war of gas and bacteriological methods of warfare' signed in Geneva in 1925 and known as the 'Geneva Protocol'.

The principal elements of the 1972 convention are:
- To ban the development, production and stockpiling of biological agents or toxins for other than peaceful purposes.
- To ban all weapons, equipments or means of delivery for agents or toxins. The destruction of all existing agents, toxins and weapons within nine months.
- There are to be no transfers of agents or toxins and no assistance is to be given to other states, except in the field of peaceful activities.

Despite having been in force for many years, the BWC has been perceived as being inadequate to tackle the proliferation of biological weapons and this was reinforced by the revelations of programmes in the former USSR and Iraq. The fourth BWC review conference in 1996 endorsed the need for improved verification and stronger measures are being explored by an Ad Hoc Group. As at January 2000, a total of 183 nations had ratified or acceded to the BWC. The fifth review conference in 2001 tried to achieve a legally binding compliance and verification protocol, including declarations of facilities, on-site inspections, exchange of data, agreeing definitions and ensuring the confidentiality of information. However, the USA rejected this protocol, saying that inspections and verification were unrealistic as biological weapons facilities were too easy to conceal. Another problem is that the equipment and facilities used to cultivate BW agents are essentially the same as those used for the commercial production of vaccines, antibiotics, vitamins, pesticides, feed supplements and even beer and yoghurt. The Ad Hoc Group struggled to find a satisfactory compromise between surprise inspections against military programmes, and preventing the compromise of new industrial processes. In November 2001 the USA proposed that each individual government should promote legislation banning biological weapons, and that a UN agency should investigate any suspicious outbreaks of disease. It is possible that a group of concerned nations will work together to introduce a protocol that includes inspections and new verification measures, without the USA.

Prevention of Nuclear War Agreement (1973)

There seems little merit in this particular agreement, since it simply agrees that the former USSR and USA would try to avoid nuclear war.

The key elements of this agreement are:
- To pursue policies that remove the danger of nuclear war.
- To refrain from threats or the use of force against each other or their allies in circumstances that might endanger international peace and security.

The Threshold Test Ban Treaty (19741

The full 'title of this treaty is the 'Treaty between the USA and the USSR on the Limitation of Underground Nuclear Weapon Tests'.

The single purpose of this treaty was to limit the size of underground nuclear tests to 150 kT, in the first instance to limit the usefulness of tests in developing new warheads, but also to further their declared aims in controlling nuclear weapons and demonstrating co-operation in so doing. The introduction of a specified limit, required a common base for determining the size of explosions and the treaty included provision for the exchange of calibration data to achieve this. For a variety of reasons very little progress was made on this aspect; calibration tests and data exchange did not take place until 1988.

The key treaty provisions are:
- The limitation of underground nuclear test yields to 150 kT.
- The exchange of calibration data between the two parties.

The September 1996 Comprehensive Test Ban Treaty will, when ratified, replace the Threshold Test Ban Treaty and ban all nuclear tests.

The SALT 2 Treaty (1979)

The attitudes set and revealed through the process of agreeing SALT 1 were continued through the follow up in SALT 2. The objectives of limitation were unaltered, with limits set on launchers and in addition, on the permitted degree of fractionation, that is the number of warheads to be allowed for each category of missile. Valuable advances were made through finding ways to include airborne cruise missiles, achieved by classifying heavy bombers as MIRV launch platforms. The varying preferences of the two parties for land- and sea-basing of their ballistic missiles were met by inclusion of an interchangeability option. No limits were set for those parameters that could not be readily verified, notably accuracy and warhead yield. This shortcoming revealed another of the weaknesses of arms control treaties; where there are missile qualities or performance characteristics that cannot be readily monitored or verified, there cannot be agreement to constrain them. Thus the absence of effective controls sets the ground for future technology improvements.

There was a protocol to the treaty, which additionally banned Air-to-Surface Ballistic Missiles (ASBM), the deployment of mobile land-based ICBM launchers and importantly, cruise missiles with ranges greater than 600 km on ground- and sea-based launchers. The protocol had an expiry date of 31 December 1981.

In the aftermath of the Soviet invasion of Afghanistan, the US Congress declined to ratify the treaty; however, both sides stated

that they intended to abide by the terms agreed. Neither side has done this, the former Soviet Union using the non-ratification of the treaty as their reason not to reduce their missile holdings and the USA using both Soviet Union non-compliance and the passing of the expiry date. The USA deployed long-range SLCMs early in 1982 and formally announced its intention to exceed the strategic nuclear delivery vehicle limit in 1987.

The purpose of the SALT 2 Treaty was to establish common limits for missile launchers and their warheads and to extend the limits to cover new systems such as cruise missiles.

The principal provisions were:

- An aggregate limit of 2,400 (2,250 by the end of 1981) on strategic nuclear delivery vehicles which includes ICBMs, SLBMs and heavy bombers.
- An aggregate limit of 1,320 on MIRV systems.
- A sub-limit of 1,200 on MIRVed ballistic missiles.
- A sub-limit of 820 on MIRVed ICBMs.
- A warhead limit of 10 on land-based missiles.
- A warhead limit of 14 on sea-based missiles.
- A limit of 28 on the number of cruise missiles on new bombers and 20 on existing types of bomber.
- A ban on new heavy ballistic missiles.
- A limit of one new light ballistic missile.

The protocol provisions were:

- A ban on ASBMs.
- A ban on long-range GLCM and SLCM.
- A ban on the deployment of mobile ICBM launchers.

Establishment of Nuclear Risk Reduction Centres (1987)

This agreement formalised the establishment of Nuclear Risk Reduction Centres in Moscow and Washington DC, connected by secure data links so that in the event of accidental or unauthorised missile launches, both leaders could communicate information rapidly to prevent an unwanted nuclear exchange. This agreement built upon the earlier, 1971, Risk Reduction Measures.

The key elements of this agreement are:

- To establish Nuclear Risk Reduction Centres in Moscow and Washington DC.
- To establish a secure facsimile link between these centres using INTELSAT and STATSIONAR satellite communications.
- To notify each other of planned ballistic missile launches.

Following the agreement between the Russian Federation and the USA in June 2000 to set-up a Joint Ballistic Missile Early Warning Centre in Moscow by June 2001 (delayed until June 2002). the Risk Reduction Centres will presumably become redundant. The Joint Centre will have separate Russian and US data inputs monitoring all Russian and US ballistic missile and satellite launch vehicle flights, and any inconsistencies can be discussed face-to-face by the monitoring teams. The introduction of internet connections, in addition to the secure datalinks already established, would enable national command centres to be kept up to date with any unusual incidents.

Missile Technology Control Regime (1987)

The– first guidelines of the Missile Technology Control Regime (MTCR) were published by the original seven signatory nations in April 1987, but these were increased to 22 signatories in January 1993. In 1995, the Russian Federation and Ukraine agreed to abide by the MTCR guidelines. China is reported to have reached understandings with the USA in 1991, 1993 and 1995 regarding MTCR, with China agreeing not to export complete missiles to other nations, but the USA remained dissatisfied and a further agreement was reached with China in November 2000. Israel and Turkey joined the MTCR in 1998, and South Korea became the 33rd signatory in March 2001. In 1996, the USA again tried to get North Korea's agreement to abide by the MTCR guidelines and to terminate the No-dong and Taep'o-dong ballistic missile programmes, but North Korea has not yet agreed. Ukraine was allowed to retain existing ballistic missiles and to develop new ballistic missiles with ranges below 500 km. Reported breaches of the MTCR guidelines by the Russian Federation and China have undermined confidence in the agreements reached earlier, and export of an adapted APACHE cruise missile by France and the UK to the United Arab Emirates in 1998 caused considerable concern about the MTCR. China has consistently protested that the MTCR is discriminatory, particularly objecting to US military equipment sold to Taiwan. The MTCR is not a treaty and the actual controls remain the national responsibility of each of the participating countries, which remains its most significant weakness. There have been some notable successes and some notable failures by the MTCR, and views remain divided as to its value.

The 1987 guidelines were aimed at the control of nuclear capable ballistic and cruise missiles with payloads exceeding 500 kg and ranges exceeding 300 km. The 1993 revision included chemical and biological payloads and removed the specific payload and range figure limitations. The removal of the specific payload and range figures quoted in the 1987 guidelines was in recognition of the fact that ballistic and cruise missile designs can trade a reduced payload for an increased range or vice versa. The MTCR does not yet include manned aircraft, although they can carry payloads well over 500 kg for ranges exceeding 300 km. The cruise missile designation is not defined, and with the 1993 changes could be applied to air-, ground-, ship- or submarine-launched air-to-surface and surface-to-surface missiles having a wide range of payload and range capabilities.

The main provision of the MTCR are:

- To control the transfer of weapons of mass destruction, and of components that could contribute to these weapons.
- The controls apply to ballistic missiles, space launch vehicles, sounding rockets, unmanned air vehicles, cruise missiles, targets and reconnaissance drones. The controls do not apply to manned aircraft.
- The controls also apply to equipment, technologies, design and manufacturing capabilities associated with weapons of mass destruction.

The INF Treaty (1987)

The full title is the 'Treaty between the USA and the USSR on the Elimination of their Intermediate Range and Shorter Range Missiles'.

The purpose of this treaty was to remove a category of land-based nuclear weapon launchers, those with missile ranges between 500 and 5,500 km. Given that no limits were placed on airborne or seaborne missiles in the same categories, which could replace the land-based ones, the rationale for the treaty basis was not self-evident. In the margins of this treaty, there were agreements to change the definition of 'range', for these categories of missiles, to the operational figure rather than the maximum computed value, this has the effect of reducing range values by some 30 per cent. The use of land-based ballistic missiles in these categories as ASAT launchers was specifically permitted.

The range definition change was important, as it removed a constant source of disagreement. The new definition sets the maximum range at that tested to in flight trials, which was much easier to verify than the notional computed range. This definition has been extended to an agreed position in other treaties and agreements.

Despite the clarity with which the INF Treaty was written, it led to complaints similar to those made about earlier treaties. The Soviet Union complained about the US plans to replace the Lance missile and threatened in response to halt withdrawal of the SS-23 system. The USA noted the advantages of the current Russian position on short-range nuclear missile systems. with many more launchers and advanced technologies already in the field.

The treaty was notable for the introduction of intrusive inspection of the kind that had been sought by the West for many years and for achieving, for the first time, reductions in levels rather than the setting of limits at existing levels.

The principal provisions of the INF Treaty are:

- Elimination of land-based ballistic and cruise missiles with ranges of 500 to 5,500 km.
- Alteration of the range definition from calculated 'maximum' to 'the maximum range to which it has been tested'.
- Exception to the ban for application of launchers for other uses (such as SAM, ASAT or research).

In 1996, it was confirmed that although all the Russian-owned SS-23 missiles had been destroyed by 1991, some exported missiles still remained. The inspections agreed under this treaty were completed in May 2001.

Notification of Launches of ICBM and SLBM (1988)

This agreement revised the previous agreements, on Nuclear Risk Reduction Centres (1987) and Risk Reduction Measures (1971), to introduce a specific requirement for the USA and the former USSR to notify details of all planned ICBM and SLBM launches at least 24 hours in advance. The information is passed via the

national Nuclear Risk Reduction Centres, but this task is expected to be transferred to the Joint Russian Federation and USA Ballistic Missile Early Warning Centre to be set-up in Moscow by June 2002.

The key element of this agreement is:

- To give at least 24 hours notice of all ICBM and SLBM launches including the date of launch, the launch area, and impact area.

The START 1 Treaty (1991)

The Strategic Arms Reduction Treaty 1 (START 1) was signed on 31 July 1991, but was not formally ratified until December 1994. This delay was due to the break-up of the former Soviet Union and the need for ratification by the Russian Federation, Belarus, Ukraine and Kazakhstan, these being the countries of the former USSR retaining strategic nuclear weapons on their territories. START 1 was the outcome of a long, drawn-out process called the 'Strategic Arms Reduction Talks', which started in June 1982, stopped in December 1983, restarted in January 1985 and then continued slowly through the rest of the 1980s. These talks were suspended for six months after the US Presidential elections in November 1988 and recommenced in June 1989. During 1989, the USA withdrew its proposal to ban mobile ICBM, contingent on US Congress funding for two US mobile ICBM programmes (rail garrison for Peacekeeper and the new SICBM). Both these programmes were subsequently cancelled. It was also agreed that the strategic defence and SLCM issues could be resolved separately from START 1.

There had been a large measure of agreement between the USA and the former Soviet Union on some of the proposed reductions, notably on the numbers relating to missiles and warheads. Given the ever increasing costs of these systems and the rising antipathy towards them in society, such reductions would be very welcome and politically attractive. However, the improvements in accuracy, yield and reliability of missile systems that resulted from exploitation of the SALT 2 freedoms, had reached such levels that fewer warheads were needed to achieve the same military objectives as before. It is significant on this particular point that the former Soviet Union seemed prepared to accept the largest reductions on their most accurate system, the SS-18, even though there were no compensating reductions on the USA side, where there are no missiles in this 'heavy' category. This was a clear indication not only of the growing Russian accuracy capability, but of their appreciation of the reductions in silo numbers the USA must make to meet the proposed numerical limits on missile launchers.

Whilst the START 1 agreement consists of several documents, the Treaty has 19 articles, with a further 10 protocols and annexes referenced in the articles but containing implementation details of the agreements in the Treaty. The Treaty text contains the rules by which the strategic offensive forces will be reduced.

The principal elements of the START 1 provisions are:

- The reductions will be made in three phases over a seven year period, to be completed in 2001.
- A limit of 1,600 strategic nuclear delivery vehicles.
- A limit of 6,000 accountable strategic nuclear warheads (ICBM, SLBM, ALCM).
- A sub-limit of 4,900 ballistic missile carried nuclear warheads (ICBM and SLBM).
- A sub-limit of 1,540 nuclear warheads on 154 heavy ICBM for the USSR (SS-18 'Satan').
- A sub-limit of 1,100 nuclear warheads on mobile ICBM.
- In addition, a separate declaration would limit nuclear SLCM with ranges in excess of 600 km. to 880 missiles.

Belarus and Kazakhstan completed the return of nuclear warheads to Russia and the destruction of silos by 1996. Ukraine completed by October 2001, and both Russia and the USA completed their agreed reductions by December 2001. However, the nuclear warheads from decommissioned missiles remain in storage in Russia and the USA.

The START 2 Treaty (1993)

The Strategic Arms Reduction Treaty 2 (START 2) was signed on 3 January 1993, by the Russian Federation and the USA, but required ratification of the START 1 Treaty before START 2 could itself be ratified. Shortly after the signing of START 1 Presidents Bush and Gorbachev met to discuss proposals for further arms reductions. It seems to have become apparent to both the Russian Federation and the USA that they could neither afford nor need to keep such large numbers of strategic nuclear weapons in service as agreed at START 1.

The USA ratified START 2 in January 1996, but the Russian Federation did not ratify the treaty until April 2000. The Russian ratification was also subject to US agreement to the START 2 protocol and ABM treaty protocol agreed in 1997 between Presidents Yeltsin and Clinton. It seems unlikely that the US Senate will agree to the ABM treaty protocol, which included other former USSR states in the ABM treaty and established a definition limiting the capability of theatre missile defence systems. There are still Russian concerns about the costs to modify and destroy missiles and silos, NATO enlargement and a decision to deploy even a limited US national missile defence. Russia is also concerned about the cost of having only single-warhead land-based ICBM, and the limitation imposed by the 1987 INF treaty on missiles with ranges below 5,500 km.

The principal elements of the START 2 provisions are:

- The further reductions, beyond START 1, will be made by 2003 (amended to 2007 in 1997).
- A limit of 3,500 nuclear warheads.
- A sub-limit of 1,750 SLBM warheads.
- There will be no heavy ICBM (SS-18 'Satan').
- A sub-limit of 1,100 mobile land-based ICBM, each with one warhead.
- All ICBM limited to one warhead.
- The downloading limit rules of START 1 are relaxed.
- Nuclear warheads carried on heavy bombers will all be counted.

The March 1997 meeting in Helsinki between Presidents Yeltsin and Clinton recommended a START 3 reduction to between 2,000 and 2,500 strategic nuclear warheads. Following the ratification of START 2, the Russian Federation and the USA started discussions on START 3. A second part to the 1997 Helsinki agreement was to delay the implementation of START 2 reductions until 2007, but to deactivate warheads on the required number of missiles by 2003 and to destroy all excess nuclear warheads with an effective verification process. Following discussions in 2001, the Russians repeated that they were prepared to reduce to 1,500 strategic nuclear warheads, and the USA proposal reduced their number to between 1,700 and 2,200 warheads. These statements indicate that START 2 has been overtaken by the reality of the situation, and will probably be sidelined.

Chemical Weapons Convention (1993)

The Chemical Weapons Convention (CWC) was signed in Paris in 1993 by 130 nations, and 141 nations had signed by December 2001. The earlier 1925 Geneva Protocol banned the use of chemical weapons in war, but did not prohibit nations from the manufacture and storage of chemical weapons and contained no provisions for verification. The CWC entered into force in April 1997, following the 65th ratification and by December 2001, a total of 140 nations had ratified the convention including the Russian Federation and the USA.

The principle elements of the CWC provisions are:

- The development, production, stockpiling, transfer or use of chemical weapons are banned.
- All existing weapons and production facilities are to be destroyed within 10 years (by April 2007).
- Any chemical weapons abandoned on the territory of another state are to be destroyed within 10 years (by April 2007).
- Schedule 1 chemicals are effectively banned from use in all industrial processes and will be controlled.
- States are to declare all stocks and facilities for chemical weapons and commercial chemical production.
- Routine and challenge inspections will be carried out as verification measures.

During the first year of implementation of the CWC, over 200 inspections were made in 25 countries. Up to April 2000, over 685 inspections had been made in 35 countries, including 35 chemical weapon storage sites and 65 production facilities. However, several nations have not yet signed the convention, including Angola, Egypt, Iraq, Libya, North Korea and Syria. There is no doubt that the Russian Federation has a major task to afford the destruction of its large stocks of chemical weapons and 24 production facilities, and it is unlikely to meet the requirement to destroy 20 per cent of all category 1 weapons by 2002. The USA had destroyed 20 per cent of its category 1 weapons by October 2001, but both the Russian Federation and the USA are likely to require

up to 2012 to completely destroy all weapons. The verification process is being reviewed and a report will be made hoping to address the difficult issue of differentiation between chemicals used for weapons production and for peaceful purposes.

Comprehensive Test Ban Treaty (1996)

Detailed discussions towards a Comprehensive Test Ban Treaty (CTBT) started in January 1994 and were concluded in June 1996 without complete agreement. In an unusual solution, the United Nations General Assembly voted overwhelmingly, by 158 votes to 3, to open the draft CTBT for signature in September 1996. There were 130 signatures by the end of October 1996, and by December 2001, 160 states had signed the treaty and 69 had ratified as well. The CTBT requires that all 44 countries possessing nuclear facilities must ratify the treaty before it can come into effect, and at December 2001 only 31 had ratified the treaty. At present, of these 44 named countries, India, Pakistan and North Korea have not even signed and, while France, Russian Federation and UK have ratified, China, Iran, Israel, Ukraine and the USA have not yet ratified the treaty. The rejection of ratification by the US Senate in October 1999 was probably due to domestic politics rather than international arms control issues, but nevertheless cast a shadow of suspicion over long-term US commitments to arms reduction.Some nuclear weapons specialists warn that new lower cost and more reliable weapons will be needed to replace an ageing international inventory, and that limited tests will be essential in the development of these weapons.

The CTBT is intended to prevent further nuclear development by banning all tests; but existing stockpiles can be monitored using computer simulations and zero yield tests, and countries without nuclear weapons could still build simple first generation weapons (but could not test them). Following their nuclear weapon tests in May 1998, India and Pakistan indicated a willingness to sign the treaty, but have not yet done so. Following ratification by the 44 named states the CTBT organisation is preparing to locate and staff 320 monitoring stations and 15 test laboratories in 90 countries around the world. At April 2000 around one third of the facilities were ready for use.

The principle elements of the CTBT are:

- All nuclear weapon tests are banned, including peaceful nuclear explosions.
- A Conference Organisation with an executive council of 51 member countries will administer the treaty.
- An international monitoring system will be set-up using seismic, hydroacoustic, infrasound and radionuclide particle monitors.
- On-site inspections may be made at short notice against any country.

Additional arms limitation prospects

The Wassenaar Agreement, signed in December 1995, has attempted to control the export of materials, components and systems for use in building warheads of mass destruction and conventional weapons. There are two control lists to the Agreement, one for munitions and one for dual-use goods and technologies. The munitions list includes seven categories: tanks; armoured combat vehicles; heavy artillery; combat aircraft and unmanned air vehicles; military and attack helicopters; warships; and missiles. The 33 signatories remain divided over the powers that should be ascribed to the Agreement, some wanting it to be purely informative, while others want to be able to veto selected exports particularly if members have already declined to export these items to a particular country. The principle arms exporters not members of the agreement are Brazil, China, Israel and South Africa. The first review conference was held in December 1999, but few changes were made as all 33 members have to agree before changes can be implemented. It was agreed that the addition of short-range surface-to-air missiles and small arms would be considered, and a report prepared for the next review conference.

In 1998 the United Nations discussed a proposed treaty aimed at preventing nuclear terrorist attacks, to be known as the Convention on the Suppression of Nuclear Terrorism.

Although the Fissile Material Cut-off Treaty (FMCT) was first proposed in 1995, little progress has been made, and a new target date of 2005 was agreed at the NPT review conference in April 2000. The problem is in deciding whether or not to include existing stocks or just monitor future manufacture. As several nations are still making fissile material, and the CTBT is not yet ratified, there seems little prospect of an agreement in the near future.

The Conference on Disarmament (CD), based in Geneva, has drafted the major multinational arms control treaties and agreements from 1968 onwards. In 1968 there were 31 states members, but by 1996 the number had grown to 66. Non-member states can submit proposals and can attend plenary sessions. The CD is funded through the United Nations, and uses UN facilities in Geneva. The UN General Assembly mandated the CD to draft treaties and agreements, for submitting to the UN for signature and ratification by individual states. The CD works by consensus, which means in effect that any state can veto topics to be discussed or appointees to committees, and this has made progress since 1996 very slow. The CD has been unable to agree which topics should be negotiated, and proposals have included a Fissile Material Cut-Off Treaty, Nuclear Disarmament, and a new Outer Space Treaty. None of the proposals have been agreed by the CD, and alternative methods have been used to circumvent the CD process. A global ban on anti-personnel land mines was achieved at the Ottawa Conference in 1998, with interested nations meeting at a separate conference in Canada to agree on this treaty. It seems likely that future treaties and agreements will be negotiated in a similar process, effectively sidelining the CD.

In addition to the treaties agreed and discussed previously, there are several additional areas that bear on strategic weapons, where treaty limitations are possible over the next few years. These include Active Defence Systems, Strategic and Tactical Nuclear Warhead Reductions, and Anti-SATellite constraints (ASAT). Although there are no agreements in these areas, there are positions taken that are interesting and the topics merit some discussion.

Active Defence Systems

It is important to note at the outset that the Russian Federation remained constant in its defence of the status of the ABM treaty, despite the fact that it is now 30 years old, and clearly needs some revision. It is certain that the Russians realised that the US was deeply divided over any re-interpretation of the treaty, and wanted to gain some reciprocal benefit before agreeing to any changes requested by the USA. The US decision to give notice of withdrawal from the ABM treaty in December 2001 came as no surprise, except that the timing was unexpected during the last days of the war against the Taliban and Al-Qaeda in Afghanistan.

On the question of the issues themselves, the ABM Treaty has proved more resilient to interpretative attack because of the way in which it was written. Rather than specify everything to be allowed, as was generally the style of arms limitation treaties, it bans everything and then lists exceptions. The effect of this is that new approaches and technologies are automatically excluded. The debate in the 1980s tended to be based on the question of whether items, such as space-based mirrors for reflecting laser beams, were components themselves, or whether they were non-weapon related components. If they were classed as non-weapon related components, like early warning systems, then space basing would be permissible. The debate today is centred on the US approaching a decision to deploy a limited National Missile Defence (NMD) system, and the concern of the Russian Federation that such a system would be improved incrementally over the years until it could withstand a retaliatory strike. China is also very concerned, even though it is not a signatory to the ABM treaty, as it sees its limited strategic nuclear deterrent force being neutralised.

Other definitional problems have arisen over such terms as 'research'. When the ABM Treaty was negotiated, it was agreed that research was that which took place 'in the laboratory' and that, in the main, that which took place 'outside the laboratory' was bordering on development. However, the space capabilities of both the former Soviet Union and the USA that have emerged since that time have placed some 'laboratories' in space, carrying with it the implication that space-based research could be legitimately carried out in that environment. The implication that a laboratory would always, and necessarily, be on the ground is now part of the dispute.

The US Reagan Administration did not concede its position on the broad interpretation of the terms and conditions of the ABM Treaty, which would allow it to carry out virtually all of its planned SDI work. Largely in the face of opposition in

the US Congress, both the Reagan and Bush Administrations agreed to abide by the existing narrow or restrictive interpretation. In doing so, the USA nevertheless made clear that it might avail itself of the provision to withdraw from the ABM Treaty when the need arose (which it was entitled to do under Article **XV,** with six months notice). However, the break up of the USSR in 1991 has rendered the re-negotiation of the ABM Treaty more difficult, and the Clinton Administration had to consider carefully the implications of any changes. Both the Russian Federation and the USA face prospective ballistic missile threats from other nations and initially wished to establish clear guidelines to clarify the boundaries between strategic and theatre defence systems.

In early 1988, the USA presented a draft Defence and Space Treaty (DST), which sought to clarify the definitional issues, permit the deployment of space-based sensors of all kinds and to allow the deployment of very small numbers of space-based ABM components for testing purposes. In 1989, the former Soviet Union agreed to dismantle the Krasnoyarsk radar, accepting that this was in breach of the ABM Treaty, but at the same time requesting the USA to reconsider the status of the Thule and Fylingdales radars. It was also agreed in 1989 that the Defence and Space Talks continue separately from START, with the aim of finding a solution to the introduction of strategic defence systems. By 1992, the emphasis had moved from the need to renegotiate the ABM Treaty to legitimise strategic ballistic missile defence, to clarification of the divisions between strategic and theatre missile defences to allow theatre missile defence systems deployments in the late 1990s.

Talks also started in 1992 between the Russian Federation and the USA concerning a possible joint or even international early warning control centre to provide shared warning of ballistic missile or space vehicle launches, together with some initial discussions examining possible future shared ABM or ATBM research technologies. A meeting in May 1995 between President Yeltsin and President Clinton agreed essentially to take the heat out of the ABM Treaty debate to assist in the ratification of START 2. The agreements reached in May 1995 are reported to be that theatre missiles would be defined as having a range of up to 3,500 km and a re-entry velocity less than 5 km/s, and that defensive interceptors would be deemed to be treaty compliant as long as they were tested against targets that remained below these two limits. This was confirmed in 1997. The USA had wanted to define limiting numbers of interceptor missiles and overall system capabilities, but eventually agreed to a statement that theatre missile defences may be deployed, provided they would not affect the strategic balance between the Russian Federation and USA at START 2 levels. In December 1995, it was reported that interceptors with a maximum velocity below 3 km/s would be considered ABM Treaty compliant and that higher velocity systems would be subject to further negotiations. An agreed text on phase 1 issues, relating to interceptor systems with a maximum velocity below 3 km/sec, was due to have been signed in October 1996 and followed by further phase 2 negotiations on higher velocity interceptors. However, the signing was delayed and was eventually completed in August 1997. This cleared the way to legitimise the Russian SA-12 system and the USA THAAD development as theatre defence missile systems, outside the ABM Treaty. The August 1997 agreement also banned the development and testing of space-based interceptors and required an annual exchange of data on TMD programmes.

While the interceptor velocity and target limitations have been widely publicised. the ABM Treaty Standing Consultative Committee (SCC) have also been discussing the inclusion of Ukraine, Belarus and Kazakhstan, and confidence building measures including advance notice of theatre missile defence tests, the observation of all tests, notification of interceptor capabilities, numbers and locations. Agreement was reached in November 1996 to include Belarus, Kazakhstan and Ukraine as states parties to the ABM Treaty. The more difficult phase 2 issues on higher velocity (over 3 km/s) interceptors were agreed in August 1997, by limiting tests of such interceptors against targets with velocities below 5 km/s and ranges below 3,500 km. These agreements do not address all the outstanding issues; including the use of nuclear warheads on interceptors, space-based sensors and cueing systems, laser weapons, tests against multiple targets or limitations to the number or location of theatre defence interceptor launchers and missiles. The maximum interceptor velocity has not been clarified, as in 1997 it was agreed that future interceptors with velocities over 3 km/s would be discussed at a later date. There were clearly possible problems with the USAF's Airborne Laser and Space-Based Infra-Red Sensor (SBIRS), the US Navy Theatre Wide (SM-3 Standard/LEAP) interceptor, and the US National Missile Defense (NMD) programmes.

The US Congress said that it would not consider the 1997 and 1998 agreements on demarcation (between theatre and ABM defence systems) or succession (the inclusion of Belarus, Kazakhstan and Ukraine) until the Russian Federation ratified START 2. The Russian Federation stated that it required an agreement on the ABM Treaty before ratification of START 2. There has been growing awareness that time and expense are together reducing the nuclear warhead numbers at least as fast as the START process. Sooner or later there had to be a radical reappraisal of the ABM Treaty, as it is clearly unsuited for two nations that need to establish a friendship and understanding based on mutual respect, in place of the suspicions of the Cold War era. The Russian Federation ratified START 2 in April 2000, but made this conditional on US agreements on the 1997 ABM treaty protocols. The recognition by both countries that strategic and tactical nuclear weapon numbers have to be reduced has started discussions on a possible START 3 agreement, but the US determination to proceed with its NMD programme has placed a premium on the political skills of the two new Presidents. The USA discussed all the issues again with Russia through 2001, particularly the introduction of longer range ballistic missile threats from other nations. The USA found that the demarcation issues between strategic (ABM) and tactical or theatre defences were so intertwined, and the ABM treaty restrictions so difficult to interpret, that the selected course of action was to give notice of withdrawal from the treaty. The USA will then be free to test a NMD system as it wishes, even though the actual system may not be operational for many years. The major issue now becomes, what should be done in the area of arms control treaties. Should a new treaty on Active Defence Systems be negotiated, possibly a multinational treaty this time, or should any defence be allowed.

START 3

The tide of public and political opinion appears to be moving gradually towards the realisation that even the START 2 nuclear warhead numbers represent a massive over-kill and considerable cost on the Russian Federation and USA, and that further reductions will eventually be required. START 2 was ratified by the Russian Federation in April 2000, but talks at Helsinki in March 1997 started on START 3 issues. Proposals for START 3 in 1997 suggested numbers of strategic nuclear warheads for the Russian Federation and USA varying between 2,000 and 2,500 each, with this number reached by December 2007, improved arrangements to prevent accidental or unauthorised launches and a ban on the production of nuclear weapons materials.

In addition, surplus strategic nuclear warheads would be destroyed, with adequate verification provisions. It is possible that some of these provisions will come into force through other treaties, but at the present time, the actual cost of dismantling and destroying the many thousands of surplus nuclear warheads from the START 1 reductions will determine the realism of agreeing on yet further reductions. On the other hand, the Russian Federation may not be able to afford to build sufficient new ICBMs, such as the SS-27, to reach 2,000 nuclear warheads by 2007. It seems likely therefore, that START 3 might eventually agree to a lower figure, possibly as low as 1,000 to 1,500 nuclear warheads for both the Russian Federation and USA. Unfortunately, this also presents some difficult problems for both countries, as the existing nuclear triads of air-launched, land-based and submarine-launched missiles would no longer be economically viable, and one service at least would have to lose its nuclear deterrent role. In addition, the USA military has made it clear that to reduce below 2,000 warheads would require a major strategic review of national priorities.

A possible START 4 agreement has been suggested, that would involve all nuclear weapons countries to seek a balance between the START 3 levels of the Russian

Federation and the USA with the warhead numbers in the other nations. It is time for the START negotiations to take into account the large number of tactical nuclear warheads still available to the Russian Federation and USA, which have not been considered at all in the strategic nuclear warhead reductions. There are no accurate figures for the numbers of tactical nuclear weapons available to either country, and the START 1/2 counting rules only consider the number of launcher platforms, and do not provide an accurate count of actual strategic nuclear warheads. The present START 3 proposals call for warhead destruction, the inclusion of tactical nuclear warhead numbers, and the consideration of fissile material stocks and their location. The Russian Federation proposed a reduction to 1,500 strategic nuclear warheads in April 2000, and in November 2001 the USA proposed to unilaterally reduce to between 1,700 and 2,200 strategic nuclear warheads by 2011. The USA appears to prefer individual states to decide their own reductions, in preference to a lengthy international treaty negotiation process.

Treaty status of ASATs

At the present time, there are no formal constraints on the use of ASAT systems, except in the very indirect sense that the 1967 Outer Space Treaty bans the use of weapons of mass destruction in outer space. This treaty would offer little constraint to ASAT usage if such weapons were valuable for such an application, as neither of the constraining terms, 'weapons of mass destruction' nor 'outer space', is defined within the treaty. As has been discussed earlier, such ambiguities are common in treaties, which rely more on their intentions of goodwill than on substance to achieve their aims.

On the question of more recent attempts to produce treaties relating to the direct banning of ASATs, various attempts have been made over the years, driven largely by the increasing importance and value of the satellite constellations of the major powers. These attempts have, however, invariably stalled on verification issues. ASAT launchers would be indistinguishable from any others to the remote observer, and neither side finding acceptable the level of intrusion a more meaningful and direct inspection would demand. Nevertheless, the US Congress persisted in hoping that some common ground could be found with the Russian Federation for a treaty to ban ASATs, and prevented the US Air Force from finalising the testing of its airborne launch system, to the point that it was cancelled in 1988.

The present position on the desire of the major powers to achieve an ASAT ban is difficult to judge. Discussions continue but while they do so, both the US Congress and the INF Treaty introduced new freedoms for developing ASAT systems. Since it agreed to the inclusion of this clause in the INF Treaty, the Russian Federation no doubt intended to exploit the ASAT option as well. There have been no reported tests of ASAT systems since the mid 1980s. but the strategic importance of military satellite systems makes one suspect that both countries have probably had black (classified) programmes to prepare an ASAT system in case of an emergency. The USA continued with the design and ground development tests of various ASAT systems through the 1990s. and reports suggest that both Russia and China have had similar programmes.

The value of the Treaty process

It is clearly desirable that the major powers throughout the world maintain a dialogue on the subject of their strategic nuclear forces and on warheads of mass destruction, and that some degree of concern for stability and constraint is demonstrated. It is welcome when some real lowering of threat levels results from such discussions, as indeed it has in the really important areas dealing with emergencies and accidental launches, via the 'hotline'.

The lessons from the earlier SALT Treaties were that these contributed little to the actual limitation or reduction in numbers of strategic nuclear weapons between the USA and former Soviet Union, resulting more in the exploitation of freedoms expressed within the treaties. START 1 will be seen in retrospect to have been too little and too late; too little in that the reductions eventually agreed in the Treatywere already being overtaken by the need to reduce the cost of existing nuclear forces that were far in excess of what was really required, and too late as the break-up of the former Soviet Union removed the likelihood of a direct confrontation between the two super powers in any case. START 2 has indicated a more realistic understanding of the need to greatly reduce the numbers of strategic nuclear warheads, but has also thrown into focus the equally difficult task of dismantling and disposing of such large quantities of nuclear materials safely. It remains to be seen if the reductions proposed by START 2 will be implemented, or if the lower numbers being suggested for START 3 will be achievable by 2007. For the future, arms control treaties will have to be made not just between the two super powers, but between the many nuclear weapon nations of the world as nuclear warhead and strategic delivery system technologies proliferate. In addition, the threat posed by the development of biological and chemical weapons, that could injure or kill as many people as nuclear weapons, means that these weapons will have to be included in any future global arms control treaty.

There have now been five nuclear weapon free zone treaties signed; the Antarctic Treaty of 1959, the Thatelolco Treaty of 1967 (covering the Latin American and Caribbean countries), the Rarotonga Treaty of 1986 (covering the south Pacific Ocean countries), the Pelindaba Treaty of 1996 (covering Africa), and the South East Asia Nuclear Weapon Free Zone (SEANWF2) Treaty of 1996. These treaties ban the research, development, use or storage of nuclear weapons, but leave to individual countries the decision whether or not to allow visiting ships or aircraft to carry nuclear weapons.

In May 1997, the NATO-Russian Founding Act was signed, with an agreement to set-up a Permanent Joint Council as a mechanism for consultation and co-ordination. There will be two meetings a year at both the foreign and defence minister level, two meetings a year at chiefs of staff, and monthly meetings at the ambassador and military level. It is too early to see how this agreement will work out in practise, but any improved understanding between NATO and the Russian Federation can only be for the good.

It is difficult to forecast the future for arms control, but the piecemeal political approaches adopted by most governments in the 1990s needs to be replaced with a coherent long-term strategy. Any new treaty needs to encompass both offensive and defensive force levels, and needs to provide an assurance to all countries that any aggressor will be met with a united response from the remainder. This would provide the weaker states with reassurance, and would use the deterrence powers of the stronger states to support the weaker states.

The proliferation of ballistic and cruise missiles, together with warheads of mass destruction has been addressed by the MTCR, but some nations, particularly Russia and China, have been concerned with the interpretations made within this regime. Russian proposals were discussed in March 2000 and February 2001 to create a Global Control System, to restrict proliferation. Over 70 countries attended the second conference, including all the MTCR countries except the USA, with China, Iran, North Korea and Pakistan. International pre-launch or test notification, incentives for nations not to acquire missiles or WMD, and an international forum to discuss proliferation issues on a regular basis were proposed. The Russians offered to prepare a draft agreement for the UN, with states then free to sign and ratify if they wished.

The evidence appears to be that the public feels that treaties are, of themselves, good things because they bring nations together, if only to talk. At the same time, students of the treaty process appear correct in their analyses that agreements are sometimes militarily counter-productive. This leaves, as residual value, the contentment that the treaty process itself brings; as this creates a forum for understanding, it may be sufficient to justify the effort involved.

Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water

5 August 1963

The governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland, and the Union of Soviet Socialist Republics, hereinafter referred to as the 'Original Parties',

Proclaiming as their principal aim the speediest possible achievement of an agreement on general and complete disarmament under strict international control in accordance with the objectives of the United Nations which would put an end to the armaments race and eliminate the incentive to the production and testing of all kinds of weapons, including nuclear weapons,

Seeking to achieve the discontinuance of all test explosions of nuclear weapons for all time, determined to continue negotiations to this end, and desiring to put an end to the contamination of man's environment by radioactive substances,

Have agreed as follows:

Article I

1. Each of the Parties to this Treaty undertakes to prohibit, to prevent, and not to carry out any nuclear weapon test explosion, or any other nuclear explosion, at any place under its jurisdiction or control:

(a) in the atmosphere; beyond its limits, including outer space; or under water, including territorial waters or high seas; or

(b) in any other environment if such explosion causes radioactive debris to be present outside the territorial limits of the State under whose jurisdiction or control such explosion is conducted. It is understood in this connection that the provisions of this subparagraph are without prejudice to the conclusion of a treaty resulting in the permanent banning of all nuclear test explosions, including all such explosions underground, the conclusion of which, as the Parties have stated in the Preamble to this Treaty, they seek to achieve.

2. Each of the Parties to this Treaty undertakes furthermore to refrain from causing, encouraging, or in any way participating in, the carrying out of any nuclear weapon test explosion, or any other nuclear explosion, anywhere which would take place in any of the environments described, or have the effect referred to, in paragraph 1 of this Article.

Article II

1. Any Party may propose amendments to this Treaty. The text of any proposed amendment shall be submitted to the Depositary Governments which shall circulate it to all Parties to this Treaty. Thereafter, if requested to do so by one-third or more of the Parties, the Depositary Governments shall convene a conference, to which they shall invite all the Parties, to consider such amendment.

2. Any amendment to this Treaty must be approved by a majority of the votes of all the Parties to this Treaty, including the votes of all the Original Parties. The amendment shall enter into force for all Parties upon the deposit of instruments of ratification by a majority of all the Parties, including the instruments of ratification of all of the Original Parties.

Article III

1. This Treaty shall be open to all States for signature. Any State which does not sign this Treaty before its entry into force in accordance with paragraph three of this Article may accede to it at any time.

2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the Original Parties—the United States of America, the United Kingdom of Great Britain and Northern Ireland, and the Union of Soviet Socialist Republics—which are hereby designated the Depositary Governments.

3. This Treaty shall enter into force after its ratification by all the Original Parties and the deposit of their instruments of ratification.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification of and accession to this Treaty, the date of its entry into force, and the date of receipt of any requests for conferences or other notices.

6. This Treaty shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

Article IV

This Treaty shall be of unlimited duration.

Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty if it decides that extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other Parties to the Treaty three months in advance.

Article V

This Treaty, of which the English and Russian texts are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

Treaty on Principles Governing the Activites of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies

27 January 1967

The States Parties to this Treaty,

Inspired by the great prospects opening up before mankind as a result of man's entry into outer space,

Recognizing the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes,

Believing that the exploration and use of outer space should be carried on for the benefit of all peoples irrespective of the degree of their economic or scientific development,

Desiring to contribute to broad international co-operation in the scientific as well as the legal aspects of the exploration and use of outer space for peaceful purposes,

Believing that such co-operation will contribute to the development of mutual understanding and to the strengthening of friendly relations between States and peoples,

Recalling resolution 1962 (XVIII), entitled 'Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space', which was adopted unanimously by the United Nations General Assembly on 13 December 1963,

Recalling resolution 1884 (XVIII), calling upon States to refrain from placing in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction or from installing such weapons on celestial bodies, which was adopted unanimously by the United Nations General Assembly on 17 October 1963.

Taking account of United Nations General Assembly resolution 110 (II) of 3 November 1947, which condemned propaganda designed or likely to provoke or encourage any threat to the peace, breach of the peace or act of aggression, and considering that the aforementioned resolution is applicable to outer space,

Convinced that a Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, will further the Purposes and Principles of the Charter of the United Nations,

Have agreed as follows:

Article I

The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interest of all countries, irrespective of their degree of economic or scientific development, and shall be the province of mankind.

Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.

There shall be freedom of scientific investigation in outer space, including the moon and other celestial bodies, and States shall facilitate and encourage international co-operation in such investigation.

Article II

Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty. by means of use or occupation, or by any other means.

Article III

States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding.

Article IV

States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.

The moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall also not be prohibited.

Article V

States Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas. When astronauts make such a landing, they shall be safely and promptly returned to the State of registry of their space vehicle.

In carrying on activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance to the astronauts of other States Parties.

States Parties to the Treaty shall immediately inform the other States Parties to the Treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the moon and other celestial bodies, which could constitute a danger to the life or health of astronauts.

Article VI

States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

Article VII

Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on Earth, in air space or in outer space, including the moon and other celestial bodies.

Article VIII

A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

Article IX

In the exploration and use of outer space, including the moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty. States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the moon and other celestial bodies, may request consultation concerning the activity or experiment.

Article X

In order to promote international co-operation in the exploration and use of outer space, including the moon and other celestial bodies, in conformity with the purposes of this Treaty, the States Parties to the Treaty shall consider on a basis of equality any requests by other States Parties to the Treaty to be afforded an opportunity to observe the flight of space objects launched by those States.

The nature of such an opportunity for observation and the conditions under which it could be afforded shall be determined by agreement between the States concerned.

Article XI

In order to promote international co-operation in the peaceful exploration and use of outer space, including the moon and other celestial bodies, States Parties to the Treaty conducting activities in outer space, including the moon and other celestial bodies, agree to inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature. conduct, locations and results of such activities. On receiving the said information, the Secretary-General of the United Nations should be prepared to disseminate it immediately and effectively.

Article XII

All stations, installations, equipment and space vehicles on the moon and other celestial bodies shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity. Such representatives shall give reasonable advance notice of a projected visit, in order that appropriate consultations may be held and that maximum precautions may be taken to assure safety and to avoid interference with normal operations in the facility to be visited.

Article XIII

The provisions of this Treaty shall apply to the activities of States Parties to the Treaty in the exploration and use of outer space, including the moon and other celestial bodies, whether such activities are carried on by a single State Party to the Treaty or jointly with other States, including cases where they are carried on within the framework of international inter-governmental organizations.

Any practical questions arising in connection with activities carried on by international inter-governmental organizations in the exploration and use of outer space, including the moon and other celestial bodies, shall be resolved by the States Parties to the Treaty either with the appropriate international organization or with one or more States members of that international organization, which are Parties to this Treaty.

Article XIV

1. This Treaty shall be open to all States for signature. Any State which does not sign this Treaty before its entry into force in accordance with paragraph 3 of this Article may accede to it at any time.
2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland and the Union of Soviet Socialist Republics, which are hereby designated the Depositary Governments.
3. This Treaty shall enter into force upon the deposit of instruments of ratification by five Governments including the Governments designated as Depositary Governments under this Treaty.
4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.
5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification of and accession to this Treaty, the date of its entry into force, and other notices.
6. This Treaty shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

Article XV

Any State Party to the Treaty may propose amendments to this Treaty. Amendments shall enter into force for each State Party to the Treaty accepting the amendments upon their acceptance by a majority of the States Parties to the Treaty and thereafter for each remaining State Party to the Treaty on the date of acceptance by it.

Article XVI

Any State Party to the Treaty may give notice of its withdrawal from the Treaty one year after its entry into force by written notification to the Depositary Governments. Such withdrawal shall take effect one year from the date of receipt of this notification.

Article XVII

This Treaty, of which the English, Russian, French, Spanish and Chinese texts are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

Treaty on the Non-Proliferation of Nuclear Weapons (NPT)

1 July 1968

The States concluding this Treaty, hereinafter referred to as the 'Parties to the Treaty',

Considering the devastation that would be visited on all mankind by a nuclear war and the consequent need to make every effort to avert the danger of such a war and to take measures to safeguard the security of peoples,

Believing that the proliferation of nuclear weapons would seriously enhance the danger of nuclear war,

In conformity with resolutions of the United Nations General Assembly calling for the conclusion of an agreement on the prevention of wider dissemination of nuclear weapons,

Undertaking to co-operate in facilitating the application of International Atomic Energy Agency safeguards on peaceful nuclear activities,

Expressing their support for research, development and other efforts to further the application, within the framework of the International Atomic Energy Agency safeguards system, **of** the principle of safeguarding effectively the flow of source and special fissionable materials by use of instruments and other techniques at certain strategic points,

Affirming the principle that the benefits of peaceful applications of nuclear technology, including any technological by-products which may be derived by nuclear-weapon States from the development of nuclear explosive devices, should be available for peaceful purposes to all Parties of the Treaty, whether nuclear-weapon or non-nuclear weapon States,

Convinced that, in furtherance of this principle, all Parties to the Treaty are entitled to participate in the fullest possible exchange of scientific information for, and to contribute alone or in co-operation with other States to, the further development of the applications of atomic energy for peaceful purposes,

Declaring their intention to achieve at the earliest possible date the cessation of the nuclear arms race and to undertake effective measures in the direction of nuclear disarmament,

Urging the co-operation of all States in the attainment of this objective,

Recalling the determination expressed by the Parties to the 1963 Treaty banning nuclear weapon tests in the atmosphere, in outer space and under water in its Preamble to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to this end,

Desiring to further the easing of international tension and the strengthening of trust between States in order to facilitate the cessation of the manufacture of nuclear weapons, the liquidation of all their existing stockpiles, and the elimination from national arsenals of nuclear weapons and the means of their delivery pursuant to a treaty on general and complete disarmament under strict and effective international control,

Recalling that, in accordance with the Charter of the United Nations, States must refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any State, or in any other manner inconsistent with the Purposes of the United Nations, and that the establishment and maintenance of international peace and security are to be promoted with the least diversion for armaments of the world's human and economic resources,

Have agreed as follows:

Article I

Each nuclear-weapon State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly; and not in any way to assist, encourage, or induce any non-nuclear-weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices.

Article II

Each non-nuclear-weapon State Party to the Treaty undertakes not to receive the transfer from any transferor whatsoever of nuclear weapons or other nuclear explosive devices or of control over such weapons or explosive devices directly, or indirectly; not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices.

Article III

1. Each non-nuclear-weapon State Party to the Treaty undertakes to accept safeguards, as set forth in an agreement to be negotiated and concluded with the International Atomic Energy Agency in accordance with the Statute of the International Atomic Energy Agency and the Agency's safeguards system, for the exclusive purpose of verification of the fulfillment of its obligations assumed under this Treaty with a view to preventing diversion of nuclear energyfrom peaceful uses to nuclear weapons or other nuclear explosive devices. Procedures for the safeguards required by this Article shall be followed with respect to source or special fissionable material whether it is being produced or used in any principal nuclear facility or is outside any such facility. The safeguards required by this Article shall be applied to all source or special fissionable material in all peaceful nuclear activities within the territoryof such State, under its jurisdiction, or carried out under its control anywhere.
2. Each State Party to the Treaty undertakes not to provide: (a) source or special fissionable material, or (b) equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-nuclear-weapon State for peaceful purposes, unless the source or special fissionable material shall be subject to the safeguards required by this article.

3. The safeguards required by this Article shall be implemented in a manner designed to comply with Article IV of this Treaty, and to avoid hampering the economic or technological development of the Parties or international co-operation in the field of peaceful nuclear activities, including the international exchange of nuclear material and equipment for the processing, use or production of nuclear material for peaceful purposes in accordance with the provisions of this Article and the principle of safeguarding set forth in the Preamble of the Treaty.
4. Non-nuclear-weapon States Party to the Treaty shall conclude agreements with the International Atomic Energy Agency to meet the requirements of this Article either individually or together with other States in accordance with the Statute of the International Atomic Energy Agency. Negotiation of such agreements shall commence within 180 days from the original entry into force of this Treaty. For States depositing their instruments of ratification or accession after the 180 day period, negotiation of such agreements shall commence not later than the date of such deposit. Such agreements shall enter into force not later than eighteen months after the date of initiation of negotiations.

Article IV

1. Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with Articles I and II of this Treaty.
2. All the Parties to the Treaty undertake to facilitate, and have the right to participate in the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy. Parties to the Treaty in a position to do so shall also co-operate in contributing alone or together with other States or international organizations to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world.

Article V

Each Party to the Treaty undertakes to take appropriate measures to ensure that, in accordance with this Treaty, under appropriate international observation and through appropriate international procedures, potential benefits from any peaceful applications of nuclear explosions will be made available to non-nuclear-weapon States Party to the Treaty on a nondiscriminatory basis and that the charge to such Parties for the explosive devices used will be as low as possible and exclude any charge for research and development. Non-nuclear-weapon States Party to the Treaty shall be able to obtain such benefits, pursuant to a special international agreement or agreements, through an appropriate international body with adequate representation of non-nuclear-weapon States. Negotiations on this subject shall commence as soon as possible after the Treaty enters into force. Non-nuclear-weapon States Party to the Treaty *so* desiring may also obtain such benefits pursuant to bilateral agreements.

Article VI

Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control.

Article VII

Nothing in this Treaty affects the right of any group of States to conclude regional treaties in order to assure the total absence of nuclear weapons in their respective territories.

Article VIII

1. Any Party to the Treaty may propose amendments to this Treaty. The text of any proposed amendment shall be submitted to the Depositary Governments which shall circulate it to all Parties to the Treaty. Thereupon, if requested to do so by one-third or more of the Parties to the Treaty, the Depositary Governments shall convene a conference, to which they shall invite all the Parties to the Treaty, to consider such an amendment.
2. Any amendment to this Treaty must be approved by a majority of the votes of all the Parties to the Treaty, including the votes of all nuclear-weapon States Party to the Treaty and all other Parties which, on the date the amendment is circulated, are members of the Board of Governors of the International Atomic Energy Agency. The amendment shall enter into force for each Party that deposits its instrument of ratification of the amendment upon the deposit of such instruments of ratification by a majority of all the Parties, including the instruments of ratification of all nuclear-weapon States Party to the Treaty and all other Parties which, on the date the amendment is circulated, are members of the Board of Governors of the International Atomic Energy Agency. Thereafter, it shall enter into force for any other Party upon the deposit of its instrument of ratification of the amendment.
3. Five years after the entry into force of this Treaty, a conference of Parties to the Treaty shall be held in Geneva, Switzerland, in order to review the operation of this Treaty with a view to assuring that the purposes of the Preamble and the provisions of the Treaty are being realized. At intervals of five years thereafter, a majority of the Parties to the Treaty may obtain, by submitting a proposal to this effect to the Depositary Governments, the convening of further conferences with the same objective of reviewing the operation of the Treaty.

Article IX

1. This Treaty shall be open to all States for signature. Any State which does not sign this Treaty before its entry into force in accordance with paragraph 3 of this Article may accede to it at any time.
2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland and the Union of Soviet Socialist Republics, which are hereby designated the Depositary Governments.
3. This Treaty shall enter into force after its ratification by the States, the Governments of which are designated as Depositaries of the Treaty, and forty other States signatory to this Treaty and the deposit of their instruments of ratification. For the purposes of this Treaty, a nuclear-weapon State is one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January 1967.
4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.
5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession, the date of the entry into force of this Treaty and the date of receipt of any requests for convening a conference or other notices.
6. This Treaty shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

Article X

1. Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty if it decides that extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other Parties to the Treaty and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.
2. Twenty-five years after the entry into force of the Treaty, a conference shall be convened to decide whether the Treaty shall continue in force indefinitely, or shall be extended for an additional fixed period or periods. The decision shall be taken by a majority of the Parties to the Treaty.

Article XI

This Treaty, the English, Russian, French, Spanish and Chinese texts of which are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Seabed and the Ocean Floor and in the Subsoil Thereof

11 February 1971

The States Parties to this Treaty,

Recognizing the common interest of mankind in the progress of the exploration and use of the seabed and the ocean floor for peaceful purposes,

Considering that the prevention of a nuclear arms race on the seabed and the ocean floor serves the interests of maintaining world peace, reduces international tensions and strengthens friendly relations among States,

Convinced that this Treaty constitutes a step towards the exclusion of the seabed, the ocean floor and the subsoil thereof from the arms race,

Convinced that this Treaty constitutes a step towards a treaty on general and complete disarmament under strict and effective international control, and determined to continue negotiations to this end,

Convinced that this Treaty will further the purposes and principles of the Charter of the United Nations, in a manner consistent with the principles of international law and without infringing the freedoms of the high seas,

Have agreed as follows:

Article I

1. The States Parties to this Treaty undertake not to emplant or emplace on the seabed and the ocean floor and in the subsoil thereof beyond the outer limit of a seabed zone, as defined in article II, any nuclear weapons or any other types of weapons of mass destruction as well as structures, launching installations or any other facilities specifically designed for storing, testing or using such weapons.
2. The undertakings of paragraph 1 of this article shall also apply to the seabed zone referred to in the same paragraph, except that within such seabed zone, they shall not apply either to the coastal State or to the seabed beneath its territorial waters.
3. The States Parties to this Treaty undertake not to assist, encourage or induce any State to carry out activities referred to in paragraph 1 of this article and not to participate in any other way in such actions.

Article II

For the purpose of this Treaty, the outer limit of the seabed zone referred to in article 1 shall be coterminous with the twelve-mile outer limit of the zone referred to in part II of the Convention on the Territorial Sea and the Contiguous Zone, signed at Geneva on April 29,1958, and shall be measured in accordance with the provisions of part I, section II, of that Convention and in accordance with international law.

Article III

1. In order to promote the objectives of and insure compliance with the provisions of this Treaty, each State Party to the Treaty shall have the right to verify through observations the activities of other States Parties to the Treaty on the seabed and the ocean floor and in the subsoil thereof beyond the zone referred to in article I, provided that observation does not interfere with such activities.
2. If after such observation reasonable doubts remain concerning the fulfillment of the obligations assumed under the Treaty, the State Party having such doubts and the State Party that is responsible for the activities giving rise to the doubts shall consult with a view to removing the doubts. If the doubts persist, the State Party having such doubts shall notify the other States Parties, and the Parties concerned shall cooperate on such further procedures for verification as may be agreed, including appropriate inspection of objects, structures, installations or other facilities that reasonably may be expected to be of a kind described in article I. The Parties in the region of the activities, including any coastal State, and any other Party so requesting, shall be entitled to participate in such consultation and cooperation. After completion of the further procedures for verification, an appropriate report shall be circulated to other Parties by the Party that initiated such procedures.
3. If the State responsible for the activities giving rise to the reasonable doubts is not identifiable by observation of the object, structure, installation or other facility, the State Party having such doubts shall notify and make appropriate inquiries of States Parties in the region of the activities and of any other State Party. If it is ascertained through these inquiries that a particular State Party is responsible for the activities, that State Party shall consult and cooperate with other Parties as provided in paragraph 2 of this article. If the identity of the State responsible for the activities cannot be ascertained through these inquiries, then further verification procedures, including inspection, may be undertaken by the inquiring State Party, which shall invite the participation of the Parties in the region of the activities, including any coastal State, and of any other Party desiring to cooperate.
4. If consultation and cooperation pursuant to paragraphs 2 and 3 of this article have not removed the doubts concerning the activities and there remains a serious question concerning fulfillment of the obligations assumed under this Treaty, a State Party may, in accordance with the provisions of the Charter of the United Nations, refer the matter to the Security Council, which may take action in accordance with the Charter.
5. Verification pursuant to this article may be undertaken by any State Party using its own means, or with the full or partial assistance of any other State Party, or through appropriate international procedures within the framework of the United Nations and in accordance with its Charter.
6. Verification activities pursuant to this Treaty shall not interfere with activities of other States Parties and shall be conducted with due regard for rights recognized under international law, including the freedoms of the high seas and the rights of coastal States with respect to the exploration and exploitation of their continental shelves.

Article IV

Nothing in this Treaty shall be interpreted as supporting or prejudicing the position of any State Party with respect to existing international conventions, including the 1958 Convention on the Territorial Sea and the Contiguous Zone, or with respect to rights or claims which such State Party may assert, or with respect to recognition or non-recognition or rights or claims asserted by any State, related to waters off its coasts, including, *inter alia,* territorial seas and contiguous zones, or to the seabed and the ocean floor, including continental shelves.

Article V

The Parties to this Treaty undertake to continue negotiations in good faith concerning further measures in the field of disarmament for the prevention of an arms race on the seabed, the ocean floor and the subsoil thereof.

Article VI

Any State Party may propose amendments to this Treaty. Amendments shall enter into force for each State Party accepting the amendments upon their acceptance by a majority of the States Parties to the Treaty and, thereafter, for each remaining State Party on the date of acceptance by it.

Article VII

Five years after the entry into force of this Treaty, a conference of Parties to the Treaty shall be held at Geneva, Switzerland, in order to review the operation of this Treaty with a view to assuring that the purposes of the preamble and the provisions of the Treaty are being realized. Such review shall take into account any relevant technological developments. The review conference shall determine, in accordance with the views of a majority of those Parties attending, whether and when an additional review conference shall be convened.

Article VIII

Each State Party to this Treaty shall in exercising its national sovereignty have the right to withdraw from this Treaty if it decides that extraordinary events related to the subject matter of this Treaty have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other States Parties to the Treaty and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it considers to have jeopardized its supreme interests.

Article IX

The provisions of this Treaty shall in no way affect the obligations assumed by States Parties to the Treaty under international instruments establishing zones free from nuclear weapons.

Article X

1. This Treaty shall be open for signature to all States. Any State which does not sign the Treaty before its entry into force in accordance with paragraph 3 of this article may accede to it at any time.
2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and of accession shall be deposited with the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland, and the Union of Soviet Socialist Republics, which are hereby designated the Despositary Governments.
3. This Treaty shall enter into force after the deposit of instruments of ratification by twenty-two Governments, including the Governments designated as Depositary Governments of this Treaty.
4. For states whose instruments of ratification or accession are deposited after the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.
5. The Depositary Governments shall promptly inform the Governments of all signatory and acceding States of the date of each signature, of the date of deposit of each instrument of ratification or of accession, of the date of the entry into force of this Treaty, and of the receipt of other notices.
6. This Treaty shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

Article XI

This Treaty, the English, Russian, French, Spanish and Chinese texts of which are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the States signatory and acceding thereto.

IN WITNESS WHEREOF the undersigned, being duly authorized thereto, have signed this Treaty.
DONE in triplicate, at the cities of Washington, London and Moscow, this eleventh day of February, one thousand nine hundred seventy-one.

Agreement on Measures To Reduce the Risk of Outbreak of Nuclear War Between the United States of America and the Union of Soviet Socialist Republics

30 September 1971

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties:

Taking into account the devastating consequences that nuclear war would have for all mankind, and recognizing the need to exert every effort to avert the risk of outbreak of such a war, including measures to guard against accidental or unauthorized use of nuclear weapons,

Believing that agreement on measures for reducing the risk of outbreak of nuclear war serves the interests of strengthening international peace and security, and is in no way contrary to the interests of any other country,

Bearing in mind that continued efforts are also needed in the future to seek ways of reducing the risk of outbreak of nuclear war,

Have agreed as follows:

Article 1

Each Party undertakes to maintain and to improve, as it deems necessary, its existing organizational and technical arrangements to guard against the accidental or unauthorized use of nuclear weapons under its control.

Article 2

The Parties undertake to notify each other immediately in the event of an accidental, unauthorized or any other unexplained incident involving a possible detonation of a nuclear weapon which could create a risk of outbreak of nuclear war. In the event of such an incident, the Party whose nuclear weapon is involved will immediately make every effort to take necessary measures **to** render harmless or destroy such weapon without its causing damage.

Article 3

The Parties undertake to notify each other immediately in the event of detection by missile warning systems of unidentified objects, or in the event of signs of interference with these systems or with related communications facilities. If such occurrences could create a risk of outbreak of nuclear war between the two countries.

Article 4

Each Party undertakes to notify the other Party in advance of any planned missile launches if such launches will extend beyond its national territory in the direction of the other Party.

Article 5

Each Party, in other situations involving nuclear incidents, undertakes to act in such a manner as to reduce the possibility of its actions being misinterpreted by the other Party. In any such situation, each Party may inform the other Party or request information when in its view, this is warranted by the interests of averting the risk of outbreak of nuclear war.

Article 6

For transmission of urgent information, notifications and requests for information in situations requiring prompt clarification, the Parties shall make primary use of the Direct Communications Link between the Governments of the United States of America and the Union of Soviet Socialist Republics.

For transmission of other information, notification and requests for information, the Parties, at their own discretion, may use any communications facilities, including diplomatic channels, depending on the degree of urgency.

Article 7

The Parties undertake to hold consultations, as mutually agreed, to consider questions relating to implementation of the provisions of this Agreement, as well as to discuss possible amendments thereto aimed at further implementation of the purposes of this Agreement.

Article 8

This Agreement shall be of unlimited duration.

Article 9

This Agreement shall enter into force upon signature.

DONE at Washington on September 30, 1971, in two copies, each in the English and Russian languages, both texts being equally authentic.

FOR THE UNITED STATES OF AMERICA:	FOR THE UNION OF SOVIET SOCIALIST REPUBLICS:
WILLIAM P ROGERS	A GROMYKO

Interim Agreement Between the United States of America and the Union of Soviet Socialist Republics on Certain Measures with Respect to the Limitation of Strategic Offensive Arms (SALT 1)

26 May 1972

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Convinced that the Treaty on the Limitations of Anti-Ballistic Missile Systems and this Interim Agreement on Certain Measures with Respect to the Limitation of Strategic Offensive Arms will contribute to the creation of more favourable conditions for active negotiations on limiting strategic arms as well as to the relaxation of international tension and the strengthening of trust between States,

Taking into account the relationship between strategic offensive and defensive arms,

Mindful of their obligations under Article VI of the Treaty on the Non-Proliferation of Nuclear Weapons,

Have agreed as follows:

Article I

The Parties undertake not to start construction of additional fixed land-based Intercontinental Ballistic Missile (ICBM) launchers after 1 July 1972.

Article II

The Parties undertake not to convert land-based launchers for light ICBMs, or for ICBMs of older types deployed prior to 1964, into land-based launchers for heavy ICBMs of types deployed after that time.

Article III

The Parties undertake to limit Submarine-Launched Ballistic Missile (SLBM) launchers and modern ballistic missile submarines to the numbers operational and under construction on the date of signature of this Interim Agreement, and in addition to launchers and submarines constructed under procedures established by the Parties as replacements for an equal number of ICBM launchers of older types deployed prior to 1964 or for launchers on older submarines.

Article IV

Subject to the provisions of this Interim Agreement, modernization and replacement of strategic offensive ballistic missiles and launchers covered by this Interim Agreement may be undertaken.

Article V

1. For the purpose of providing assurance of compliance with the provisions of this Interim Agreement, each Party shall use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law.
2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1 of this Article.
3. Each Party undertakes not to use deliberate concealment measures which impede verification by national technical means of compliance with the provisions of this Interim Agreement. This obligation shall not require changes in current construction, assembly, conversion, or overhaul practices.

Article VI

To promote the objectives and implementation of the provisions of this Interim Agreement, the parties shall use the Standing Consultative Commission established under Article XIII of the Treaty on the Limitation of Anti-Ballistic Missile Systems in accordance with the provisions of that Article.

Article VII

The Parties undertake to continue active negotiations for limitations on strategic offensive arms. The obligations provided for in this Interim Agreement shall not prejudice the scope or terms of the limitations on strategic offensive arms which may be worked out in the course of further negotiations.

Article VIII

1. This Interim Agreement shall enter into force upon exchange of written notices of acceptance by each Party, which exchange shall take place simultaneously with the exchange of instruments of ratification of the Treaty on the Limitation of Anti-Ballistic Missile Systems.
2. This Interim Agreement shall remain in force for a period of five years unless replaced earlier by an agreement on more complete measures limiting strategic offensive arms. It is the objective of the

Parties to conduct active follow-on negotiations with the aim of concluding such an agreement as soon as possible.

3. Each Party shall, in exercising its national sovereignty, have the right to withdraw from this Interim Agreement if it decides that extraordinary events related to the subject matter of this Interim Agreement have jeopardized its supreme interests. It shall give notice of its decision to the other Party six months prior to withdrawal from this Interim Agreement. Such notice shall include a statement of the extraordinary events the notifying Party regards as having jeopardized its supreme interests.

Protocol to the Interim Agreement Between the United States of America and the Union of Soviet Socialist Republics on Certain Measures with Respect to the Limitation of Strategic Offensive Arms (SALT 1)

26 May 1972

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Having agreed on certain limitations relating to submarine-launched ballistic missile launchers and modern ballistic missile submarines, and to replacement procedures, in the Interim Agreement,

Have agreed as follows:

The Parties understand that, under Article III of the Interim Agreement, for the period during which that Agreement remains in force:

The USA may have no more than 710 ballistic missile launchers on submarines (SLBMs) and no more than 44 modern ballistic missile submarines.

The Soviet Union may have no more than 950 ballistic missile launchers on submarines and no more than 62 modern ballistic missile submarines.

Additional ballistic missile launchers on submarines up to the above-mentioned levels, in the USA over 656 ballistic missile launchers on nuclear-powered submarines, and in the USSR over 740 ballistic missile launchers on nuclear-powered submarines, operational and under construction, may become operational as replacements for equal numbers of ballistic missile launchers of older types deployed prior to 1964 or of ballistic missile launchers on older submarines.

The deployment of modern SLBMs on any submarine, regardless of type, will be counted against the total level of SLBMs permitted for the USA and the USSR.

This protocol shall be considered an integral part of the Interim Agreement.

Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems (ABM)

26 May 1972

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Proceeding from the premise that nuclear war would have devastating consequences for all mankind,

Considering that effective measures to limit anti-ballistic missile systems would be a substantial factor in curbing the race in strategic offensive arms and would lead to a decrease in the risk of outbreak of war involving nuclear weapons,

Proceeding from the premise that the limitation of anti-ballistic missile systems, as well as certain agreed measures with respect to the limitation of strategic offensive arms, would contribute to the creation of more favourable conditions for further negotiations on limiting strategic arms,

Mindful of their obligations under Article VI of the Treaty on the Non-Proliferation of Nuclear Weapons,

Declaring their intention to achieve at the earliest possible date the cessation of the nuclear arms race and to take effective measures toward reductions in strategic arms, nuclear disarmament, and general and complete disarmament,

Desiring to contribute to the relaxation of international tension and the strengthening of trust between States,

Have agreed as follows:

Article I

1. Each Party undertakes to limit Anti-Ballistic Missile (ABM) systems and to adopt other measures in accordance with the provisions of this Treaty.
2. Each Party undertakes not to deploy ABM systems for a defence of the territory of its country and not to provide a base for such a defence, and not to deploy ABM systems for defence of an individual region except as provided for in Article III of this Treaty.

Article II

1. For the purposes of this Treaty an ABM system is a system to counter strategic ballistic missiles or their elements in flight trajectory, currently consisting of:
   (a) ABM interceptor missiles, which are interceptor missiles constructed and deployed for an ABM role, or of a type tested in an ABM mode;
   (b) ABM launchers, which are launchers constructed and deployed for launching ABM interceptor missiles; and
   (c) ABM radar, which are radars constructed and deployed for an ABM role, or of a type tested in an ABM mode.
2. The ABM system components listed in paragraph 1 of this Article include those which are:
   (a) operational;
   (b) under construction;
   (c) undergoing testing;
   (d) undergoing overhaul, repair or conversion; or
   (e) mothballed.

Article III

Each Party undertakes not to deploy ABM systems or their components except that:

(a) within one ABM system deployment area having a radius of one hundred and fifty kilometers and centred on the Party's national capital, a Party may deploy: (1) no more than one hundred ABM launchers and no more than one hundred ABM interceptor missiles at launch sites, and (2) ABM radars within no more than six ABM radar complexes, the area of each complex being circular and having a diameter of no more than three kilometers; and

(b) within one ABM system deployment area having a radius of one hundred and fifty kilometers and containing ICBM silo launchers, a Party may deploy: (1) no more than one hundred ABM launchers and no more than one hundred ABM interceptor missiles at lauch sites, (2) two large phased-array ABM radars comparable in potential to corresponding ABM radars operational or under construction on the date of signature of the Treaty in an ABM system deployment area containing ICBM launchers, and (3) no more than eighteen ABM radars each having a potential less than the potential of the smaller of the above-mentioned two large phased-array ABM radars.

Article IV

The limitations provided for in Article III shall not apply to ABM systems or their components used for development or testing, and located within current or additionally agreed test ranges. Each Party may have no more than a total of fifteen ABM launchers at test ranges.

Article V

1. Each Party undertakes not to develop, test, or deploy ABM systems or components which are sea-based, air-based, space-based, or mobile land-based.

2. Each Party undertakes not to develop, test, or deploy ABM launchers for launching more than one ABM interceptor missile at a time from each launcher, nor to modify deployed launchers to provide them with such a capability, nor to develop, test, or deploy automatic or semi-automatic or other similar systems for rapid reload of ABM launchers.

Article VI

To enhance assurance of the effectiveness of the limitations on ABM systems and their components provided by this Treaty, each Party undertakes:

(a) not to give missiles, launchers or radars, other than ABM interceptor missiles, ABM launchers, or ABM radars, capabilities to counter strategic ballistic missiles or their elements in flight trajectory, and not to test them in an ABM mode; and

(b) not to deploy in the future radars for early warning of strategic ballistic missile attack except at locations along the periphery of its national territory and oriented outward.

Article VII

Subject to the provisions of this Treaty, modernization and replacement of ABM systems or their components may be carried out.

Article VIII

ABM systems or their components in excess of the numbers or outside the areas specified in this Treaty, as well as ABM systems or their components prohibited by this Treaty, shall be destroyed or dismantled under agreed procedures within the shortest possible agreed period of time.

Article IX

To assure the viability and effectiveness of this Treaty, each Party undertakes not to transfer to other States, and not to deploy outside its national territory, ABM systems or their components limited by this Treaty.

Article X

Each Party undertakes not to assume any international obligations which would conflict with this Treaty.

Article XI

The Parties undertake to continue active negotiations for limitations on strategic offensive arms.

Article XII

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law.
2. Each party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1 of this Article.
3. Each Party undertakes not to use deliberate concealment measures which impede verification by national technical means of compliance with the provisions of this Treaty. This obligation shall not require changes in current construction, assembly, conversion, or overhaul practices.

Article XIII

1. To promote the objectives and implementation of the provisions of this Treaty, the Parties shall establish promptly a Standing Consultative Commission, within the framework of which they will:

(a) consider questions concerning compliance with the obligations assumed and related situations which may be considered ambiguous;

(b) provide on a voluntary basis such information as either Party considers necessary to assure confidence in compliance with the obligations assumed;

(c) consider questions involving unintended interference with national technical means of verification;

(d) consider possible changes in the strategic situation which have a bearing on the provisions of this Treaty;

(e) agree upon procedures and dates for destruction or dismantling of ABM systems or their components in cases provided for by the provisions of this Treaty;

(f) consider, as appropriate, possible proposals for further increasing the viability of this Treaty, including proposals for amendments in accordance with the provisions of this Treaty;

(g) consider, as appropriate, proposals for further measures aimed at limiting strategic arms.

2. The Parties through consultation shall establish, and may amend as appropriate, Regulations for the Standing Consultative Commission governing procedures, composition and other relevant matters.

Article XIV

1. Each Party may propose amendment to this Treaty. Agreed amendments shall enter into force in accordance with the procedures governing the entry into force of this Treaty.
2. Five years after entry into force of this Treaty, and at five year intervals thereafter, the Parties shall together conduct a review of this Treaty.

Article XV

1. This Treaty shall be of unlimited duration.
2. Each Party shall, in exercising its national sovereignty, have the right to withdraw from this Treaty if it decides that extraordinary events related to the subject matter of this Treaty have jeopardized its supreme interests. It shall give notice of its decision to the other Party six months prior to withdrawal from the Treaty. Such notice shall include a statement of the extraordinary events the notifying Party regards as having jeopardized its supreme interests.

Article XVI

1. This Treaty shall be subject to ratification in accordance with the constitutional procedures of each Party. The Treaty shall enter into force on the day of the exchange of instruments of ratification.
2. This Treaty shall be registered pursuant to Article 102 of the Charter of the United Nations.

Agreed Interpretations and Unilateral Statements Relating to the ABM Treaty and the Interim Agreement

26 May 1972

1. Agreed interpretations

(a) INITIALLED STATEMENTS

The texts of the statements set out below were agreed upon and initialled by the Heads of Delegations on 26 May 1972.

ABM Treatv

[A]

The Parties understand that, in addition to the ABM radars which may be deployed in accordance with subparagraph (a)of Article III of the Treaty, those non-phased-array ABM radars operational on the date of signature of the Treaty within the ABM system deployment area for defence of the national capital may be retained.

[B]

The Parties understand that the potential (the product of mean emitted power in watts and antenna area in square metres) of the smaller of the two large phased-array ABM radars referred to in subparagraph (b) of Article III of the Treaty is considered for purposes of the Treaty to be three million.

[C]

The Parties understand that the centre of the ABM system deployment area centred on the national capital and the centre of the ABM system deployment area containing ICBM silo launchers for each Party shall be separated by no less than thirteen hundred kilometers.

[D]

The Parties agree not to deploy phased-array radars having a potential (the product of mean emitted power in watts and antenna area in square metres) exceeding three million, except as provided for in Articles III, IV and VI of the Treaty, or except for the purpose of tracking objects in outer space or for use as national technical means of verification.

[E]

In order to ensure fulfillment of the obligation not to deploy ABM systems and their components except as provided in Article III of the Treaty, the Parties agree that in the event ABM systems based on their physical principles and including components capable of substituting for ABM interceptor missiles, ABM launchers, or ABM radars are created in the future, specific limitations on such systems and their components would be subject to discussion in accordance with Article XIII and agreement in accordance with Article XIV of the Treaty.

[F]

The Parties understand that Article V of the Treaty includes obligations not to develop, test or deploy ABM interceptor missiles for the delivery by each ABM interceptor missile of more than one independently guided warhead.

[G]

The Parties understand that Article IX of the Treaty includes the obligation of the USA and USSR not to provide to other States technical descriptions or blueprints specially worked out for the construction of ABM systems and their components limited by the Treaty.

Interim Agreement

[H]

The Parties understand that land-based ICBM launchers referred to in the Interim Agreement are understood to be launchers for strategic ballistic missiles capable of ranges in excess of the shortest distance between the northeastern border of the continental USA and the northwestern border of the continental USSR.

[I]

The Parties understand that fixed land-based ICBM launchers under active construction as of the date of signature of the Interim Agreement may be completed.

[J]

The Parties understand that in the process of modernization and replacement the dimensions of land-based ICBM silo launchers will not be significantly increased.

[K]

The Parties understand that dismantling or destruction of ICBM launchers of older types deployed prior to 1964 and ballistic missile launchers on older submarines being replaced by new SLBM launcherson modern submarines will be initiated at the time of the beginning of sea trials of a replacement submarine, and will be completed in the shortest possible agreed period of time. Such dismantling or destruction, and timely notification thereof, will be accomplished under procedures to be agreed in the Standing Consultative Commission.

[L]

The Parties understand that during the period of the Interim Agreement there shall be no significant increase in the number of ICBM or SLBM test and training launchers, or in the number of such launchers for modern land-based heavy ICBMs. The Parties further understand that construction or conversion of ICBM launchers at test ranges shall be undertaken only for purposes of testing and training.

(b) COMMON UNDERSTANDINGS

Common understanding of the Parties on the following matters was reached during the negotiations:

A. *Increase in ICBM Silo Dimensions*

Ambassador Smith made the following statement on 26 May 1972: "The Parties agree that the term 'significantly increased' means that an increase will not be greater than 10-15 per cent of the present dimensions of land-based ICBM silo launchers."

Minister Semenov replied that this statement corresponded to the Soviet understanding.

B. *Location of ICBM Defences*

The USA Delegation made the following statement on 26 May 1972: "Article III of the ABM Treaty provides for each side one ABM system deployment area centred on its national capital and one ABM system deployment area containing ICBM silo launchers. The two sides have registered agreement on the following statements: 'The Parties understand that the centre of the ABM system deployment area centred on the national capital and the centre of the ABM system deployment area containing ICBM silo launchers for each Party shall be separated by no less than thirteen hundred kilometers.' In this connection, the USA side notes that its ABM system deployment area for defence of ICBM silo launchers, located west of the Mississippi River, will be centred in the Grand Forks ICBM silo launcher deployment area." (See Initialed Statement [C].)

C. *ABM Test Ranges*

The USA Delegation made the following statement on 26 April 1972: "Article IV of the ABM Treaty provides that 'the limitations provided for in Article III shall not apply to ABM systems or their components used for development or testing, and located within current or additionally agreed test ranges.' We believe it would be useful to assure that there is no misunderstanding as to current ABM test ranges. It is our understanding that ABM test ranges encompass the area within which ABM components are located for test purposes. The current USA ABM test ranges are at White Sands, New Mexico, and at Kwajalein Atoll, and the current Soviet ABM test range is near Sary Shagan in Kazakhstan. We consider that non-phased-array radars of types used for range safety or instrumentation purposes may be located outside of ABM test ranges. We interpret the reference in Article IV to 'additionally agreed test ranges' to mean that ABM components will not be located at any other test ranges without prior agreement between our Governments that there will be such additional ABM test ranges."

On 5 May 1972, the Soviet Delegation stated that there was a common understanding on what ABM test ranges were, that the use of the types of non-ABM radars for range safety or instrumentation was not limited under the Treaty, that the reference in Article IV to 'additionally agreed' test ranges was sufficiently clear, and that national means permitted identifying current test ranges.

D. *Mobile ABM Systems*

On 28 January 1972, the USA Delegation made the following statement: "Article V(1) of the Joint Draft Text of the ABM Treaty includes an undertaking not to develop, test, or deploy mobile land-based ABM

systems and their components. On 5 May 1971, the USA side indicated that, in its view, a prohibition on deployment of mobile ABM systems and components would rule out the deployment of ABM launchers and radars which were not permanent fixed types. At that time, we asked for the Soviet view of this interpretation. Does the Soviet side agree with the USA side's interpretation put forward on 5 May 1971?''

On 13 April 1972, the Soviet Delegation said there is a general common understanding on this matter.

E. *Standing Consultative Commission*

Ambassador Smith made the following statement on 24 May 1972: "The United States proposes that the sides agree that, with regard to initial implementation of the ABM Treaty's Article XIII on the Standing Consultative Commission (SCC) and of the consultation Articles to the Interim Agreement on offensive arms and the Accidents Agreement, agreement establishing the SCC will be worked out early in the follow-on SALT negotiations; until that is completed, the following arrangements will prevail: when SALT is in session, any consultation desired by either side under these Articles can be carried out by the two SALT Delegations; when SALT is not in session, *ad hoc* arrangements for any desired consultations under these Articles may be made through diplomatic channels."

Minister Semenov replied that, on an *ad referendum* basis, he could agree that the USA statement corresponded to the Soviet understanding.

F. *Standstill*

On 6 May 1972, Minister Semenov made the following statement: ''In an effort to accommodate the wishes of the USA side, the Soviet Delegation is prepared to proceed on the basis that the two sides will in fact observe the obligations of both the Interim Agreement and the ABM Treaty beginning from the date of signature of these two documents."

In reply, the USA Delegation made the following statement on 20 May 1972: "The USA agrees in principle with the Soviet statement made on 6 May, concerning observance of our obligations beginning from the date of signature but we would like to make clear our understanding that this means that, pending ratification and acceptance, neither side would take any action prohibited by the agreements after they had entered into force. This understanding would continue to apply in the absence of notification by either signatory of its intention not to proceed with ratification or approval."

The Soviet Delegation indicated agreement with the USA statement.

2. Unilateral Statements

(a) The following noteworthy unilateral statements were made during the negotiations by the United States Delegation:

A. *Withdrawal from the ABM Treaty*

On 9 May 1972, Ambassador Smith made the following statement: "The USA Delegation has stressed the importance the USA Government attaches to achieving agreement on more complete limitations on strategic offensive arms, following agreement on an ABM Treaty and on an Interim Agreement on certain measures with respect to the limitation of strategic offensive arms. The USA Delegation believes that an objective of the follow-on negotiations should be to constrain and reduce on a long-term basis threats to the survivability of our respective strategic retaliatory forces. The USSR Delegation has also indicated that the objectives of SALT would remain unfulfilled without the achievement of an agreement providing for more complete limitations on strategic offensive arms. Both sides recognize that the initial agreements would be steps toward the achievement of more complete limitations on strategic arms. If an agreement providing for more complete strategic offensive arms limitations were not achieved within five years, USA supreme interests could be jeopardized. Should that occur, it would constitute a basis for withdrawal from the ABM Treaty. The USA does not wish to see such a situation occur, nor do we believe that the USSR does. It is because we wish to prevent such a situation that we emphasize the importance the USA Government attaches to achievement of more complete limitations on strategic offensive arms. The USA Executive will inform the Congress, in connection with Congressional consideration of the ABM Treaty and the Interim Agreement of this statement of the US position."

B. *Land-Mobile ICBM Launchers*

The USA Delegation made the following statement on 20 May 1972: ''In connection with the important subject of land-mobile ICBM launchers, in the interest of concluding the Interim Agreement the USA Delegation now withdraws its proposal that Article I or an agreed statement explicitly prohibit the deployment of mobile land-based ICBM launchers. I have been instructed to inform you that, while agreement to defer the question of limitation of operational land-mobile ICBM launchers to the subsequent negotiations on more complete limitations on strategic offensive arms, the USA would consider the deployment of operational land-mobile ICBM launchers during the period of the Interim Agreement as inconsistent with the objectives of that Agreement."

C. *Covered Facilities*

The USA Delegation made the following statement on 20 May 1972: "I wish to emphasize the importance that the United States attaches to the provisions of Article V, including in particular their application to fitting out or berthing submarines."

D. *'Heavy' ICBMs*

The USA Delegation made the following statement on 26 May 1972: "The USA Delegation regrets that the Soviet Delegation has not been willing to agree on a common definition of a heavy missile. Under these circumstances, the USA Delegation believes it necessary to state the following: The United States would consider any ICBM having a volume significantly greater than that of the largest light ICBM now operational on either side to be a heavy ICBM. The USA proceeds on the premise that the Soviet side will give due account to this consideration."

E. *Tested in ABM Mode*

On 7 April 1972, the USA Delegation made the following statement: "Article II of the Joint Draft Text uses the term 'tested in an ABM mode,' in defining ABM components, and Article VI includes certain obligations concerning such testing. We believe that the sides should have a common understanding of this phrase. First, we would note that the testing provisions of the ABM Treaty are intended to apply to testing which occurs after the date of signature of the Treaty, and not to any testing which may have occurred in the past. Next, we would amplify the remarks we have made on this subject during the previous Helsinki phase by setting forth the objectives which govern the USA view on the subject, namely, while prohibiting testing of non-ABM components for ABM purposes: not to prevent testing of ABM components, and not to prevent testing of non-ABM components for non-ABM purposes. To clarify our interpretation of 'tested in an ABM mode,' we note that we would consider a launcher, missile or radar to be 'tested in an ABM mode' if, for example, any of the following events occur: (1) a launcher is used to launch an ABM interceptor missile, (2) an interceptor missile is flight-tested against a target vehicle which has a flight trajectory with characteristics of a strategic ballistic missile flight trajectory, or is flight-tested in conjunction with the test of an ABM interceptor missile or an ABM radar at the same test range, or is flight-tested to an altitude consistent with interception of targets against which air defences are deployed, (3) a radar makes measurements on a co-operative target vehicle of the kind referred to in item (2) above during the re-entry portion of its trajectory or makes measurements in conjunction with the test of an ABM interceptor missile or an ABM radar at the same test range. Radars used for purposes such as range safety or instrumentation would be exempt from application of these criteria."

F. *No-Transfer Article of ABM Treaty*

On 18 April 1972, the USA Delegation made the following statement: "In regard to this Article [IX], I have a brief and I believe self-explanatory statement to make. The USA side wishes to make clear that the provisions of this Article do not set a precedent for whatever provision may be considered for a Treaty on Limiting Strategic Offensive Arms. The question of transfer of strategic offensive arms is a far more complex issue, which may require a different solution."

G. No Increase in Defence of Early Warning Radars

On 28 July 1970, the USA Delegation made the following statement: "Since Hen House radars [Soviet ballistic missile early warning radars] can detect and track ballistic missile warheads at great distances, they have a significant ABM potential. Accordingly, the USA would regard any increase in the defences of such radars by surface-to-air missiles as inconsistent with an agreement."

(b) The following noteworthy unilateral statement was made by the Delegation of the USSR and is shown here with the USA reply:

On 17 May 1972, Minister Semenov made the following unilateral Statement of the Soviet Side: "Taking into account that modern ballistic missile submarines are presently in the possession of not only the USA, but also of its NATO allies, the Soviet Union agrees that for the period of effectiveness **of** the Interim 'Freeze' Agreement the USA and its NATO allies have up to 50 such submarines with a total of up to 800 ballistic missile launchers thereon (including 41 USA submarines with 656 ballistic missile launchers). However, if during the period of effectiveness of the Agreement USA allies in NATO should increase the number of their modern submarines to exceed the numbers of submarines they would have operational or under construction on the date of signature of the Agreement, the Soviet Union will have the right to a corresponding increase in the number of its submarines. In the opinion of the Soviet side, the solution of the question of modern ballistic missile submarines provided for in the Interim Agreement only partially compensates for the strategic imbalance in the deployment of the nuclear-powered missile submarines of the USSR and the USA. Therefore, the Soviet side believes that this whole question, and above all the question of liquidating the American missile submarine bases outside the USA, will be appropriately resolved in the course of follow-up negotiations."

On 24 May, Ambassador Smith made the following reply to Minister Semenov: "The United States side has studied the 'statement made by the Soviet side' of 17 May concerning compensation for submarine basing and SLBM submarines belonging to third countries. The United States does not accept the validity of the considerations in that statement."

On 26 May Minister Semenov repeated the unilateral statement made on 17 May. Ambassador Smith also repeated the USA rejection on 26 May.

Standing Consultative Commission Regulations (for the ABM Treaty)

1. The Standing Consultative Commission, established by the Memorandum of Understanding between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics Regarding the Establishment of a Standing Consultative Commission of 21 December 1972, shall consist of a USA component and Soviet component, each of which shall be headed by a Commissioner.

2. The Commissioners shall alternately preside over the meetings

3. The Commissioners shall, when possible, inform each other in advance of the matters to be submitted for discussion, but may at a meeting submit for discussion any matter within the competence of the Commission.

4. During intervals between sessions of the Commission, each Commissioner may transmit written or oral communications to the other Commissioners concerning matters within the competence of the Commission.

5. Each component of the Commission may invite such advisers and experts as it deems necessary to participate in a meeting.

6. The commission may establish working groups to consider and prepare specific matters.

7. The results of the discussion of questions at the meetings of the Commission may, if necessary, be entered into records which shall be in two copies, each in the English and the Russian languages, both texts being equally authentic.

8. The proceedings of the Standing Consultative Commission shall be conducted in private. The Standing Consultative Commission may not make its proceedings public except with the express consent of both Commissioners.

9. Each component of the Commission shall bear the expenses connected with its participation in the Commission.

Memorandum of Understanding Between the United States and the Soviet Union Regarding the Establishment of a Standing Consultative Commission for the ABM Treaty

21 December 1972

I

The Government of the United States of America and the Government of the Union of Soviet Socialist Republics hereby establish a Standing Consultative Commission.

II

The Standing Consultative Commission shall promote the objectives and implementation of the provisions **of** the Treaty between the USA and the USSR on the Limitation of Anti-Ballistic Missile Systems of 26 May 1972, the Interim Agreement between the USA and the USSR on Certain Measures with Respect to the Limitation of Strategic Offensive Arms of *26* May 1972, and the Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War Between the USA and the USSR of 30 September 1971, and shall exercise its competence in accordance with the provisions **of** Article XIII of said Treaty, Article VI of said Interim Agreement, and Article 7 of said Agreement on Measures.

III

Each Government shall be represented on the Standing Consultative Commission by a Commissioner and a Deputy Commissioner, assisted by such staff as it deems necessary.

IV

The Standing Consultative Commission shall hold periodic sessions on dates mutually agreed by the Commissioners but no less than two times per year. Sessions shall also be convened as soon as possible, following reasonable notice, at the request **of** either Commissioner.

V

The Standing Consultative Commission shall establish and approve regulations governing procedures and other relevant matters and may amend them as it deems appropriate.

VI

The Standing Consultative Commission will meet in Geneva. It may also meet at such other places as may be agreed.

Done in Geneva, on 21 December 1972, in two copies, each in the English and Russian languages, both texts being equally authentic.

Protocol to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems

3 July 1974

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Proceeding from the Basic Principles of Relations between the United States of America and the Union of Soviet Socialist Republics signed on 29 May 1972,

Desiring to further the objectives of the Treaty between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems signed on 26 May 1972, hereinafter referred to as the Treaty,

Reaffirming their conviction that the adoption of further measures for the limitation of strategic arms would contribute to strengthening international peace and security,

Proceeding from the premise that further limitation of anti-ballistic missile systems will create more favourable conditions for the completion of work on a permanent agreement on more complete measures for the limitation of strategic offensive arms,

Have agreed as follows:

Article I

1. Each Party shall be limited at any one time to a single area out of the two provided in Article III of the Treaty for deployment of Anti-Ballistic Missile (ABM) systems or their components and accordingly shall not exercise its right to deploy an ABM system or its components in the second of the two ABM systems deployment areas permitted by Article III of the Treaty except as exchange of one permitted area for the other in accordance with Article II of this Protocol.
2. Accordingly, except as permitted by Article II of this Protocol: the United States of America shall not deploy an ABM system or its components in the area centred on its capital, as permitted by Article III(a) of the Treaty, and the Soviet Union shall not deploy an ABM system or its components in the deployment area of Intercontinental Ballistic Missile (ICBM) silo launchers as permitted by Article III(b) of the Treaty.

Article II

1. Each Party shall have the right to dismantle or destroy its ABM system and the components thereof in the area where they are presently deployed and to deploy an ABM system or its components in the alternative area permitted by Article III of the Treaty, provided that prior to initiation of construction, notification is given in accord with the procedure agreed to in the Standing Consultative Commission during the year beginning 3 October 1977 and ending 2 October 1978, or during any year which commences at five year intervals thereafter, those being the years of periodic review of the Treaty, as provided in Article XIV of the Treaty. This right may be exercised only once.
2. Accordingly, in the event of such notice, the United States would have the right to dismantle or destroy the ABM system and its components in the deployment area of ICBM silo launchers and to deploy an ABM system or its components in an area centred on its capital, as permitted by Article III(a) of the Treaty, and the Soviet Union would have the right to dismantle or destroy the ABM system and its components in the area centred on its capital and to deploy an ABM system or its components in an area containing ICBM silo launchers, as permitted by Article III(b) of the Treaty.
3. Dismantling or destruction and deployment of ABM systems or their components and the notification thereof shall be carried out in accordance with Article VIII of the ABM Treaty and procedures agreed to in the Standing Consultative Commission.

Article III

The rights and obligations established by the Treaty remain in force and shall be complied with by the Parties except to the extent modified by this Protocol. In particular, the deployment of an ABM system or its components within the area selected shall remain limited by the levels and other requirements established by the Treaty.

Article IV

This Protocol shall be subject to ratification in accordance with the constitutional procedures of each Party. It shall enter into force on the day of the exchange of instruments of ratification and shall thereafter be considered an integral part of the Treaty.

Agreed Statements on Limitation of Anti-Ballistic Missile Systems

1 November 1978, 6 June 1985 and 14 June 1985

Geneva
November 1, 1978
Standing Consultative Commission

AGREED STATEMENT REGARDING CERTAIN PROVISIONS OF ARTICLES II, IV, AND VI OF THE TREATY BETWEEN THE UNITED STATES OF AMERICA AND THE UNION OF SOVIET SOCIALIST REPUBLICS ON THE LIMITATION OF ANTI-BALLISTIC MISSILE SYSTEMS OF MAY 26, 1972, AND THE UTILIZATION OF AIR DEFENSE RADARS AT THE TEST RANGES REFERRED TO IN ARTICLE IV OF THAT TREATY

In accordance with the provisions of the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26, 1972, hereinafter referred to as the Treaty, the Parties thereto have, within the framework of the Standing Consultative Commission, reached mutual understanding regarding the following:

I. Test Ranges Referred to in Article IV of the Treaty

1. The test ranges referred to in Article IV of the Treaty are any test ranges at which an ABM system or at least one ABM launcher, regardless of whether or not it contains an ABM interceptor missile, or one ABM radar is located or constructed for purposes of testing.
2. Any other types of weapons or military equipment may also be located at such test ranges for testing according to their mission or for range safety purposes. Such location, testing, or use of these other types of weapons or military equipment, provided it is consistent with the provisions of the Treaty, shall not constitute a basis for considering them ABM system components.
3. The current test ranges referred to in Article IV of the Treaty are those test ranges which each Party had on the date of signature of the Treaty, that is, on May 26, 1972. Both the USA and the USSR had on May 26, 1972, and have at the present time, two current test ranges: for the USA in the vicinity of White Sands, New Mexico, and on Kwajalein Atoll and for the USSR in the vicinity of Sary Shagan, Kazakhstan, and on the Kamchatka Peninsula.
4. Each Party may establish test ranges referred to in Article IV of the Treaty as "additionally agreed" and locate therein for testing ABM systems or their components as they are defined in Article II of the Treaty, provided that the establishment of such ranges is consistent with the objectives and provisions of the Treaty and, in particular, with the obligations of each Party provided for in Article I of the Treaty not to deploy ABM systems for a defense of the territory of its country and not to provide a base for such a defense.
5. In the event of establishment of an additional test range by either Party, the Party carrying out such action shall provide, within the framework of the Standing Consultative Commission, notification of the location of such a test range no later than thirty days after the beginning of any construction or assembly work, other than earthwork (excavation), associated with locating or constructing at that test range an ABM launcher or antenna (array), ABM radar antenna structures, or an antenna pedestal support which is not part of an ABM radar building. After presentation of such notification and, if necessary, clarification in the Standing Consultative Commission of any aspects of this notification which are not clear to the Party being notified, the test range being newly established will be considered an "additionally agreed test range," referred to in Article IV of the Treaty.

II. The Term "Tested in an ABM Mode" Used in the Treaty

1. The term "tested in an ABM mode," which is used in Article II of the Treaty for defining ABM systems components, refers to ABM interceptor missiles, ABM launchers, or ABM radars, which are tested in an ABM mode separately or in conjunction with other ABM system components after the date of signature of the Treaty, that is after May 26, 1972. The term does not refer to components which were tested by the Parties in an ABM mode prior to that date.
2. Testing in an ABM mode is the testing, which, in accordance with the provisions of Articles III and IV of the Treaty regarding locations of ABM systems or their components, is carried out only at test ranges or in an ABM system deployment area, for the purpose of determining the capabilities of an ABM system or its individual components (ABM interceptor missiles, ABM launchers, or ABM radars) to perform the functions of countering strategic ballistic missiles or their elements in flight trajectory.
3. As applied to testing of ABM interceptor missiles, ABM launchers, or ABM radars, the term "strategic ballistic missiles or their elements in flight trajectory," used in the Treaty, also refers to ballistic target-missiles which, after being launched, are used for testing these ABM systems components in an ABM mode, and the flight trajectories of which, over the portions of the flight trajectory involved in such testing, have the characteristics of the flight trajectory of a strategic ballistic missile or its elements.
4. The term "tested in an ABM mode" used in Article II of the Treaty refers to:

(a) an ABM interceptor missile if while guided by an ABM radar it has intercepted a strategic ballistic missile or its elements in flight trajectory regardless of whether such intercept was successful or not; or if an ABM interceptor missile has been launched from an ABM launcher and guided by an ABM radar. If ABM interceptor missiles are given the capability to carry out interceptions without the use of ABM radars as the means of guidance, application of the term "tested in an ABM mode" to ABM interceptor missiles in that event shall be subject to additional discussion and agreement in the Standing Consultative Commission;

(b) an ABM launcher if it has been used for launching an ABM interceptor missile;

(c) an ABM radar if it has tracked a strategic missile or its elements in flight trajectory and guided an ABM interceptor missile toward them regardless of whether the intercept was successful or not; or tracked and guided an ABM interceptor missile; or tracked a strategic ballistic missile or its elements in flight trajectory in conjunction with an ABM radar, which is tracking a strategic ballistic

missile or its elements in flight trajectory and guiding an ABM interceptor missile toward them or is tracking and guiding an ABM interceptor missile.

5. The provisions of paragraph 4 of this Section shall be applied taking into account Article VI, subparagraph (a), of the Treaty concerning the obligations of the Parties not to give missiles, launchers, or radars, other than ABM system components, capabilities to counter strategic ballistic missiles or their elements in flight trajectory. The term "tested in an ABM mode" shall not be applied to radars for early warning of strategic ballistic missile attack, or to radars, including phased-array radars, used for the purposes of tracking objects in outer space or as national technical means of verification.

6. The term "tested in an ABM mode" shall not be applied to radars, including phased-array radars, which are constructed and used only as instrumentation equipment for testing of any types of weapons or military equipment.

7. The term "tested in an ABM mode" shall not be applied to a radar, including a phased-array radar, which is not an ABM radar or a radar referred to in paragraphs 5 and 6 of this Section, if strategic ballistic missiles or their elements passed through the field of view of the radar while it was operating in accordance with its mission, and it was not, at that time, performing functions inherent only to an ABM radar, and it was not functioning in conjunction with an ABM radar. In the event that ambiguities arise in the future regarding application of the term "tested in an ABM mode" to individual radars which track strategic ballistic missiles or their elements in flight trajectory, the Parties, in accordance with Article XIII of the ABM Treaty, will consider such questions in the Standing Consultative Commission and resolve them on a mutually acceptable basis.

8. Deployment of radars of a type tested in an ABM mode, except as provided in Articles III and IV of the Treaty, to carry out any functions would be inconsistent with the obligations of each Party not to provide a base for an ABM defense of the territory of its country.

III. Utilization of Air Defense Radars at the Test Ranges Referred to in Article IV of the Treaty

1. Utilization of air defense radars located at or near a test range to carry out air defense functions, including providing for the safety of that range, is not limited by the provisions of the Treaty and is independent of the testing carried out at that range.

2. When air defense components and ABM system components are collocated at a test range, the Parties, in order to preclude the possibility of ambiguous situations or misunderstandings, will refrain from concurrent testing of such air defense components and ABM system components at that range.

3. In utilizing air defense radars as instrumentation equipment at test ranges the Parties will not use such radars to make measurements on strategic ballistic missiles or their elements in flight trajectory.

Statement by Commissioner Robert Buchheim
November 1, 1978

Mr Commissioner, I would like to make the following statement regarding the Agreed Statement which we have just initialed.

FIRST, in paragraph 6 of Section II of the Agreed Statement of November 1, 1978, the Parties agreed that the term "tested in an ABM mode" shall not be applied to radars, including phased-array radars, which are constructed and used only as instrumentation equipment for testing of any types of weapons or military equipment. With respect to such measures the Parties understand that:

(a) phased-array radars which have a potential exceeding three million may be located only at the test ranges referred to in Article IV of the ABM Treaty;

(b) phased-array radars which have a potential not exceeding three million and which make measurements on strategic ballistic missiles or their elements in flight trajectory may be located only at the test ranges referred to in Article IV of the ABM Treaty, or at locations to which strategic ballistic missiles are launched for testing;

(c) phased-array radars which have a potential not exceeding three million and which do not make measurements on strategic ballistic missiles or their elements in flight trajectory may be located anywhere for instrumentation or other purposes not inconsistent with the ABM Treaty;

(d) non-phased-array radars may be located anywhere for instrumentation or other purposes not inconsistent with the ABM Treaty.

SECOND, in connection with paragraph 7 of Section II of the Agreed Statement of November 1, 1978, the Parties understand that ABM radars, radars for early warning of strategic ballistic missile attack, radars used for tracking objects in outer space or as national technical means of verification, as well as radars constructed and used only as instrumentation equipment for testing of any types of weapons or military equipment can, when operating in accordance with their missions, perform the function inherent to them of tracking strategic ballistic missiles or their elements in flight trajectory.

In addition to the aforementioned radars, both Parties have other radars, including phased-array radars, intended for various missions. When these radars are operating in accordance with their missions, strategic ballistic missiles or their elements might pass through the fields of view of these radars. The passing of strategic ballistic missiles or their elements through the fields of view of such radars will not be equated with tracking of such missiles by these radars and cannot give grounds for either Party to consider that in these cases the radars are being tested in an ABM mode.

If ambiguities arise in the future regarding application of the term "tested in an ABM mode" to individual radars which track strategic ballistic missiles or their elements in flight trajectory, or regarding determination of whether these radars are ABM radars or radars which are not ABM radars, such questions will be subject to consultation in the Standing Consultative Commission in accordance with Article XIII of the ABM Treaty.

THIRD, the Parties, in connection with the Agreed Statement Regarding Certain Provisions of the ABM Treaty, have the common understanding that the Agreed Statement will be used by the Parties in their implementation of those provisions of the ABM Treaty, beginning on the date of initialing of the Agreed Statement by the US and the USSR SCC commissioners, that is, November 1, 1978. Like the statements in connection with paragraphs 11.6 and 11.7 of the Agreed Statement, this common understanding constitutes a component part of the general understanding reached between the

Parties with regard to certain provisions of the ABM Treaty. [Commissioner Ustinov of the USSR delivered the same statement on November 1, 1978.1

Geneva
June 6, 1985

STANDING CONSULTATIVE COMMISSION COMMON UNDERSTANDING RELATED TO PARAGRAPH 2 OF SECTION III OF THE AGREED STATEMENT OF NOVEMBER 1, 1978, REGARDING CERTAIN PROVISIONS OF ARTICLES 11, IV, AND VI OF THE TREATY BETWEEN THE UNITED STATES OF AMERICA AND THE UNION OF SOVIET SOCIALIST REPUBLICS ON THE LIMITATION OF ANTI-BALLISTIC MISSILE SYSTEMS OF MAY 26, 1972, AND THE UTILIZATION OF AIR DEFENSE RADARS AT THE TEST RANGES REFERRED TO IN ARTICLE IV OF THAT TREATY

In accordance with the provisions of the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26, 1972, hereinafter referred to as the Treaty, the Parties thereto, in further development of the agreement recorded in paragraph 2 of Section III of the Agreed Statement of November 1, 1978, with a view to precluding the possibility of ambiguous situations at the test ranges referred to in Article IV of the Treaty, have, within the framework of the Standing Consultative Commission, additionally agreed that:

– each Party will refrain from launching strategic ballistic missiles to the area of such a test range or from launching ABM interceptor missiles at that test range concurrent with the operation of air defense components located at that range;

– in agreeing to the foregoing the Parties recognize the possibility of circumstances - the appearance of a hostile or unidentified aircraft - in which, for the purpose of providing for air defense, a necessity for the operation of air defense components, located at the test range for carrying out air defense functions including providing for range safety, may arise unexpectedly during the launch of a strategic ballistic missile to the area of the test range or during the launch of an ABM interceptor missile at that range. Should such an event occur, the Party which had the concurrent operation will, as soon as possible, but within thirty days, provide notification to the other Party describing the circumstances of that event. It will, if necessary, on a voluntary basis, also inform the other Party about the event or hold consultations with it within the framework of the Standing Consultative Commission, as provided for in Article XIII of the Treaty and paragraph 4 of the Regulations of the Standing Consultative Commission.

This Common Understanding constitutes a component part of this agreement reached between the Parties with regard to the provisions of paragraph 2 of Section III of the Agreed Statement of November 1, 1978, and does not affect other provisions of that Agreed Statement or the provisions of the common understandings thereto reached by the Commissioners in the Standing Consultative Commission on November 1, 1978.

The provisions of this Common Understanding will be used by the Parties in their implementation of the provisions of the Treaty and the Agreed Statement of November 1, 1978, beginning on the date of signature of this Common Understanding, that is, June 6, 1985. [The document is signed by the Commissioners of both countries.]

Geneva
June 14, 1985

STANDING CONSULTATIVE COMMISSION COMMON UNDERSTANDING RELATED TO ARTICLES 2 AND 5 OF THE AGREEMENT ON MEASURES TO REDUCE THE RISK OF OUTBREAK OF NUCLEAR WAR BETWEEN THE UNITED STATES AND THE UNION OF SOVIET SOCIALIST REPUBLICS OF SEPTEMBER 30,1971

The Parties, in accordance with Article 7 of the Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War Between the United States of America and the Union of Soviet Socialist Republics of September 30, 1971, hereinafter referred to as the Agreement on Measures, and Paragraph II of the Memorandum of Understanding Between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics Regarding the Establishment of a Standing Consultative Commission of December 21, 1972, have agreed as follows:

The Parties understand that the phrase "unexplained nuclear incidents", found in Article 5 of the Agreement on Measures, includes the acquisition by any means, including by theft or fabrication, threat to use, or detonation of a nuclear explosive device by unknown or unauthorized individuals or groups. Furthermore, the Parties understand that the phrase "an accidental, unauthorized or in any other unexplained incident involving a possible detonation of a nuclear weapon which could create a risk of outbreak of nuclear war", found in Article 2 of the same Agreement, includes any such incident which is caused by unknown or unauthorized individuals or groups and which involves a nuclear weapon of a Party.

Memorandum Œ Understanding Relating To The Treaty Between The United States Of America And The Union Of Soviet Socialist Republics On The Limitation Of Anti-Ballistic Missile Systems Of May 26 1972

September 26 1997

The United States of America, and the Republic of Belarus, the Republic of Kazakhstan, the Russian Federation and Ukraine, hereinafter referred to for purposes of this Memorandum as the Union of Soviet Socialist Republics (USSR) Successor States,

Recognizing the importance of preserving the viability of the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26 1972, hereinafter referred to as the Treaty, with the aim of maintaining strategic stability,

Recognizing the changes in the political situation resulting from the establishment of new independent states on the territory of the former USSR,

Have, in connection with the Treaty, agreed as follows:

Article I

The United States of America, the Republic of Belarus, the Republic of Kazakhstan, the Russian Federation, and Ukraine, upon entry into force of this Memorandum, shall constitute the Parties to the Treaty.

Article II

The USSR Successor States shall assume the rights and obligations of the former USSR under the Treaty and its associated documents.

Article III

Each USSR Successor State shall implement the provisions of the Treaty with regard to its territory and with regard to its activities, wherever such activities are carried out by that State, independently or in cooperation with any other State.

Article IV

The purposes of Treaty implementation:

(a) the term "Union of Soviet Socialist Republics" shall mean the USSR Successor States;

(b) the terms "national territory" and "territory of its country" when used to refer to the former USSR shall mean the combined national territories of the USSR Successor States, and the term "periphery of its national territory" when used to refer to the former USSR shall mean the periphery of the combined national territories of those States; and

(c) the term "capital" when used to refer to the capital of the Union of Soviet Socialist Republics in Article III of the Treaty and the Protocol thereto of July 3 1974, shall continue to mean the city of Moscow.

Article V

A USSR Successor State or USSR Successor States may continue to use any facility that is subject to the provisions of the Treaty and that is currently located on the territory of any State that is not a Party to the Treaty, with the consent of such State, and provided that the use of such facility shall remain consistent with the provisions of the Treaty.

Article VI

The USSR Successor States shall collectively be limited at any one time to a single anti-ballistic missile (ABM) system deployment area and to a total of no more than fifteen ABM launchers at ABM test ranges, in accordance with the provisions of the Treaty and its associated documents, including the Protocols of July 3 1974.

Article VII

The obligations contained in Article XI of the Treaty and Agreed Statement "G" Regarding the Treaty shall not apply to transfers between or among the USSR Successor States.

Article VIII

The Standing Consultative Commission, hereinafter referred to as the Commission, shall function in the manner provided for by the Treaty and the Memorandum of Understanding Between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics Regarding the Establishment of a Standing Consultative Commission of December 21, 1972, as well as by the Regulations of the Commission, which shall reflect the multilateral character of the Treaty and the equal legal status of the Parties in reaching decisions in the Commission.

Article IX

1. This Memorandum shall be subject to ratification or approval by the signatory States, in accordance with the constitutional procedures of those States.
2. The functions of the depository of this Memorandum shall be exercised by the Government of the United States of America.

3. This Memorandum shall enter into force on the date when the Governments of all signatory States have deposited instruments of ratification or approval of this Memorandum and shall remain in force so long as the Treaty remains in force.
4. Each State that has ratified or approved this Memorandum shall also be bound by the provisions of the First Agreed Statement of September 26 1997, Relating to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26 1972, and the Second Agreed Statement of September 26 1997, Relating to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26 1972.

DONE at New York City on September 26 1997, in five copies, each in the English and Russian languages, both texts being equally authentic.

First Agreed Statement Relating To The Treaty Between The United States Of America And The Union Of Soviet Socialist Republics On The Limitation Of Anti-Ballistic Missile Systems Of May 26 1972

In connection with the provisions of the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26 1972, hereinafter referred to as the Treaty, the Parties to the Treaty have, within the framework of the Standing Consultative Commission, reached agreement on the following:

1. Land-based, sea-based, and air-based interceptor missiles, interceptor missile launchers, and radars, other than anti-ballistic missile (ABM) interceptor missiles, ABM launchers, or ABM radars, respectively, shall be deemed, within the meaning of paragraph (a) of Article VI of the Treaty, not to have been given capabilities to counter strategic ballistic missiles or their elements in flight trajectory and not to have been tested in an ABM mode, if, in the course of testing them separately or in a system:
   (a) the velocity of the interceptor missile does not exceed 3 km/sec over any part of its flight trajectory;
   (b) the velocity of the ballistic target-missile does not exceed 5 km/sec over any part of its flight trajectory: and
   (c) the range of the ballistic target-missile does not exceed 3,500 kilometers.

2. The Parties have additionally agreed on reciprocal implementation of the confidence-building measures set forth in the Agreement on Confidence-Building Measures Related to Systems to Counter Ballistic Missiles Other Than Strategic Ballistic Missiles of September 26 1997.
3. This Agreed Statement shall enter into force simultaneously with entry into force of the Memorandum of Understanding of September 26 1997, Relating to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26 1972.

DONE at New York City on September 26 1997, in five copies, each in the English and Russian languages, both texts being equally authentic.

Common Understandings Related To The First Agreed Statement Of September 26 1997, Relating To The Treaty Between The United States Of America And The Union Of Soviet Socialist Republics On The Limitation Of Anti-Ballistic Missile Systems Of May 26 1972

I

The term "interceptor missile," as used in the First Agreed Statement of September 26 1997, shall refer to any missile subject to the provisions of paragraph (a) of Article VI of the Treaty if such a missile:
   (a) has been developed by a Party as a missile to counter ballistic missiles other than strategic ballistic missiles; or
   (b) has been declared by a Party as a missile to counter ballistic missiles other than strategic ballistic missiles; or
   (c) has been tested by a Party even once with the use of a ballistic target-missile.

With respect to subparagraphs (a), (b), or (c), such a missile shall be considered an interceptor missile in all its launches.

II

The provisions of paragraph 1 of the First Agreed Statement of September 26 1997, do not supersede or amend any provision of the Agreed Statement of November 1 1978.

III

The Parties have agreed that, for the purposes of the First Agreed Statement of September 26 1997, the velocity of an interceptor missile as well as the velocity of a ballistic target-missile shall be determined in an earth-centred coordinate system fixed in relation to the Earth.

IV

The Parties have agreed that, for the purposes of the First Agreed Statement of September 26 1997, the velocity of space-based interceptor missiles shall be considered to exceed 3 km/sec.

These Common Understandings shall be considered an attachment to the First Agreed Statement of September 26 1997, and shall constitute an integral part thereof.

Second Agreed Statement Relating To The Treaty Between The United States Of America And The Union Of Soviet Socialist Republics On The Limitation Of Anti-Ballistic Missile Systems Of May 26 1972

In connection with the provisions of the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26 1972, hereinafter referred to as the Treaty, the Parties to the Treaty.

Expressing their commitment to strengthening strategic stability and international security,

Emphasizing the importance the importance of further reductions in strategic offensive arms,

Recognizing the fundamental significance of the Treaty for the above objectives,

Recognizing the necessity for effective systems to counter ballistic missiles other than strategic ballistic missiles,

Considering it their common task to preserve the Treaty, prevent its circumvention and enhance its viability,

Relying on the following principles that have served as a basis for reaching this agreement:

(a) the Parties are committed to the Treaty as a cornerstone of strategic stability;

(b) the Parties must have the option to establish and to deploy effective systems to counter ballistic missiles other than strategic ballistic missiles, and such activity must not lead to violation or circumvention of the Treaty;

(c) systems to counter ballistic missiles other than strategic ballistic missiles may be deployed by each Party which will not pose a realistic threat to the strategic nuclear force of another Party and which will not be tested to give such systems that capability;

(d) systems to counter ballistic missiles other than strategic ballistic missiles will not be deployed by the Parties for use against each other; and

(e) the scale of deployment - in number and geographic scope - of systems to counter ballistic missiles other than strategic ballistic missiles by any Party will be consistent with programs for ballistic missiles other than strategic ballistic missiles confronting that Party;

Have, within the framework of the Standing Consultative Commission, with respect to systems to counter ballistic missiles other than strategic ballistic missiles with interceptor missiles whose velocity exceeds 3 km/sec over any part of their flight trajectory, hereinafter referred to as systems covered by this Agreed Statement, reached agreement on the following:

1. Each Party undertakes that, in the course of testing, separately or in a system, land-based, sea-based, and air-based interceptor missiles, interceptor missile launchers, and radars, of systems covered by this Agreed Statement, which are not anti-ballistic missile (ABM) interceptor missiles, ABM launchers, or ABM radars, respectively:

(a) the velocity of the ballistic target-missile will not exceed 5 km/sec over any part of its flight trajectory; and

(b) the range of the ballistic target-missile will not exceed 3,500 kilometers.

2. Each Party, in order to preclude the possibility of ambiguous situations or misunderstandings related to compliance with the provisions of the Treaty, undertakes not to develop, test, or deploy space-based interceptor missiles to counter ballistic missiles other than strategic ballistic missiles, or space-based components based on other physical principles, whether or not part of a system, that are capable of substituting for such interceptor missiles.

3. In order to enhance confidence in compliance with the provisions of the Treaty, the Parties shall implement the provisions of the Agreement on Confidence-Building Measures Related to Systems to Counter Ballistic Missiles Other Than Strategic Ballistic Missiles of September 26 1997, hereinafter referred to as the Confidence-Building Measures Agreement, with respect to systems covered by this Agreed Statement and not subject to the Confidence-Building Measures Agreement on the date of its entry into force. Each such system shall become subject to the provisions of the Confidence-Building Measures Agreement no later than 180 days in advance of the planned date of the first launch of an interceptor missile of that system. All information provided for in the Confidence-Building Measures Agreement shall initially be provided no later than 30 days after such a system becomes subject to the provisions of the Confidence-Building Measures Agreement.

4. In order to ensure the viability of the Treaty as technologies related to systems to counter ballistic missiles other than strategic ballistic missiles evolve, and in accordance with Article XIII of the Treaty, the Parties undertake to hold consultations and discuss, within the framework of the Standing Consultative Commission, involving systems covered by this Agreed Statement, including questions and concerns related to the implementation of the provisions of this Agreed Statement.

5. This Agreed Statement shall enter into force simultaneously with entry into force of the Memorandum of Understanding of September 26 1997, Relating to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26 1972.

DONE at New York City on September 26 1997, in five copies, each in the English and Russian languages, both texts being equally authentic.

Common Understandings Related To The Second Agreed Statement Of September 26 1997, Relating To The Treaty Between The United States Of America And The Union Of Soviet Socialist Republics On The Limitation Of Anti-Ballistic Missile Systems Of May 26 1972

I

The term "interceptor missile," as used in the Second Agreed Statement of September 26 1997, shall refer to any missile subject to the provisions of paragraph (a) of Article VI of the Treaty if such a missile:

(a) has been developed by a Party as a missile to counter ballistic missiles other than strategic ballistic missiles; or

(b) has been declared by a Party as a missile to counter ballistic missiles other than strategic ballistic missiles; or

(c) has been tested by a Party even once with the use of a ballistic target-missile.

With respect to subparagraphs (a).(b), or (c), such a missile shall be considered an interceptor missile in all its launches.

II

The Parties have agreed that, for the purposes of the Second Agreed Statement of September 26 1997, the velocity of an interceptor missile as well as the velocity of a ballistic target-missile shall be determined in an earth-centred coordinate system fixed in relation to the Earth.

III

The Parties have agreed that for the purposes of the Second Agreed Statement of September 26 1997, the velocity of space-based interceptor missiles shall be considered to exceed 3 km/sec.

IV

For systems to counter ballistic missiles other than strategic ballistic missiles with interceptor missiles whose velocity exceeds 3 km/sec over any part of their flight trajectory, that become subject to the Confidence-Building Measures Agreement in accordance with paragraph 3 of the Second Agreed Statement of September 26 1997, the Parties understand that, in connection with the provisions of paragraph 2(b) of Section IV of the Confidence-Building Measures Agreement, detailed information on such systems shall be provided in a form and scope as agreed upon by the Parties.

These Common Understandings shall be considered an attachment to the Second Agreed Statement of September 26 1997, and shall constitute an integral part thereof.

Agreement On Confidence-Building Measures Related To Systems To Counter Ballistic Missiles Other Than Strategic Ballistic Missiles

The States that have signed this Agreement, hereinafter referred to as the Parties,

Desiring to promote reciprocal openness, greater trust between the Parties, and the preservation of strategic stability,

Declaring their intention to implement, on a reciprocal basis, confidence-building measures with respect to systems to counter ballistic missiles other than strategic ballistic missiles,

Have agreed as follows:

I. General Provisions

1. Systems subject to this Agreement shall be: for the United States of America - the Theater High-Altitude Area Defense (THAAD) System and the Navy Theater-Wide Theater Ballistic Missile Defense Program, known to the other Parties by the same names; for the Russian Federation - the S-300V system, known to the United States of America as the SA-12 system; for the Republic of Belarus - the S-300V system, known to the United States of America as the SA-12 system; for Ukraine - the S-300V system, known to the United States of America as the SA-12 system; and other systems as agreed upon by the Parties in the future.

2. The Parties shall conduct an initial exchange of information and notifications, as provided for in this Agreement, no later than 90 days after entry into force of this Agreement, reflecting the status as of the date of its entry into force, and update this information annually, unless otherwise agreed. Information shall be updated reflecting the status as of January 1 of each year and provided no later than April 1 of each year.

II. Notifications

1. Each Party shall provide notifications to the other Parties of test ranges and other test areas where launches of interceptor missiles of systems subject to this Agreement will take place. Notifications of test ranges and other test areas shall include the names of ranges (test areas) and their locations. Such notifications shall be provided either within 30 days after entry into force of this Agreement, or no later than 90 days in advance of the first launch of an interceptor missile of a system subject to this Agreement at each test range (test area).

2. Each Party shall provide notification to the other Parties of each launch of an interceptor missile of systems subject to this Agreement, if during that launch a ballistic target-missile is used. In this connection:

(a) an interceptor missile launch notification shall specify the name of the test range (test area) where the interceptor missile launch will take place; the type (designation) of the interceptor missile; the planned date of the interceptor missile launch; the planned launch point of the interceptor missile (geographic coordinates; for air-based systems the geographic coordinates of the projection of the planned launch point of the interceptor missile onto the Earth's surface shall be specified); the planned launch point of the ballistic target-missile (geographic coordinates);
(b) each interceptor missile launch notification shall be provided no later than 10 days in advance of the planned date of the interceptor missile launch and shall be effective for seven days beginning with the planned date of that launch; and
(c) if the launch of the interceptor missile will not occur or has nor occurred within the specified 7-day period, the Party that planned to carry out the launch of the interceptor missile shall provide a notification thereof no later than 24 hours after the expiration of the 7-day period. Such a notification shall state that the interceptor missile launch has not occurred and shall either specify a new launch date, which will establish the beginning of a new 7-day period, or state that a notification of a new launch date will be made in accordance with the procedure specified in subparagraph (b) of this paragraph.

III. Demonstrations of Systems and Observations of Tests

Any Party may on a voluntary basis arrange, for any other Party or Parties, a demonstration of its systems or their components subject to this Agreement or an observation of their tests. In each specific case, the participating Parties shall agree in advance on the purpose of, and the arrangementsfor, such demonstrations and observations.

IV. Assurances

Each Party shall provide assurances that it will not deploy systems subject to this Agreement in numbers and locations so that these systems could pose a realistic threat to the strategic nuclear force of another Party. The measures used to provide such assurances shall include:

1. Each Party shall provide to the other Parties, in a form and scope as agreed upon by the Parties, an assessment of the programs with respect to the development, testing and deployment of ballistic missiles, other than strategic ballistic, confronting that Party.

2. For each of its systems subject to this Agreement, each Party shall provide the following information:
(a) the name, type (designation), and basing mode of the system as well as of its interceptor missiles, launchers, and associated radars;
(b) the general concept of operation; the status of plans and programs; and, in addition, for systems in testing, the number of systems it plans to possess; the information shall be provided in a form and scope as agreed upon by the Parties;
(c) the class and type of basing platform:
(i) for land-based systems: the number of launchers in a battalion;
(ii) for sea-based systems: the class and type of each ship, and the number of launchers on a ship of that class capable of launching interceptor missiles of each type;
(iii) for air-based systems: the type of each aircraft, and the number of interceptor missiles each aircraft is capable of carrying;
(d) the number of interceptor missiles of a fully loaded launcher.

3. For components of each of its systems subject to this Agreement, each Party shall provide the following information:
(a) for a completelyassembled interceptor missile: the number of stages, the length, the maximum diameter, the type of propellant (solid or liquid), maximum velocity demonstrated during launches, and the length and diameter of the interceptor missile launch canister;
(b) for the interceptor missile launcher: the maximum number of interceptor missiles of a fully loaded launcher; and
(c) for the radar: the frequency band (in designations adopted by the International Telecommunication Union) and potential, expressed as a value that is not exceeded by the radar's potential. The potential of a radar shall mean the product of its mean emitted power in watts and its antenna area in square meters.

V. Additional Voluntary Measures

Each Party may provide on a voluntary basis any other information or any other notifications not specified elsewhere in this Agreement. The topics, amount, and time frame for such information and notifications shall be such as each Party determines.

VI. Implementation of the Agreement

1. To promote the objectives and implementation of the provisions of this Agreement, the Parties, within the framework of the Standing Consultative Commission establish in accordance with the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26 1972, shall consider:
(a) issues concerning implementation of the obligations assumed under this Agreement, as well as related situations which may be considered ambiguous; and
(b) amendments to the provisions of this Agreement and other possible proposals on further increasing its viability.

2. The Parties shall use the Nuclear Risk Reduction Center channels or the equivalent government-to-government communications links for providing the notifications and for exchanging the information provided for in Sections II, IV and V of this Agreement.

VII. Confidentiality

Each Party undertakes not to release to the public the information provided pursuant to this Agreement except with the express consent of the Party that provided such information.

VIII. Entry into Force and Duration

This Agreement shall enter into force simultaneously with entry into force of the First Agreed Statement of September 26 1997, Relating to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26 1972, and the Second Agreed Statement of September 26 1997, Relating to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26 1972, and shall remain in force so long as either of those Agreed Statement remains in force.

DONE at New York City on September 26 1997, in five copies, each in the English and Russian languages, both texts being equally authentic.

Joint Statement On The Annual Exchange Of Information On The Status Of Plans And Programs With Respect To Systems To Counter Ballistic Missiles Other Than Strategic Ballistic Missiles

1. The Parties understand that in implementing the provisions of paragraph 2(b) of Section IV of the Agreement on Confidence-Building Measures Related to Systems to Counter Ballistic Missiles Other Than Strategic Ballistic Missiles of September 26 1997, each Party will provide information annually on the status of its plans and programs with respect to systems to counter ballistic missiles other than strategic ballistic missiles that includes:

(a) whether or not that Party has plans before April 1999 to test, against a ballistic target-missile, land-based, sea-based or air-based interceptor missiles whose velocity exceeds 3 km/sec over any part of their flight trajectory;

(b) whether or not that Party has plans to develop such systems with interceptor missiles whose velocity over any part of their flight trajectory exceeds 5.5 km/sec for land-based and air-based systems or 4.5 km/sec for sea-based systems; and

(c) whether or not that Party has plans to test such systems against ballistic target-missiles with multiple independently targetable reentry vehicles or against reentry vehicles deployed or planned to be deployed on strategic ballistic missiles.

2. The Parties understand that should any Party have questions or concerns regarding activity related to any change in the statement on plans of any other Party, the Parties will, in accordance with Article XIII of the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26 1972, hereinafter referred to as the Treaty, the Second Agreed Statement of September 26 1997, Relating to the Treaty, and Section VI of the Agreement on Confidence-Building Measures Related to Systems to Counter Ballistic Missiles of September 26 1997, conduct consultations, within the framework of the Standing Consultative Commission, to discuss such questions or concerns, as well as possible proposals for further increasing the viability of the Treaty, including possible proposals to amend the Second Agreed Statement of September 26 1997.

Statement by the United States of America On Plans With Respect To Systems To Counter Ballistic Missiles Other Than Strategic Ballistic Missiles*

The United States of America states that, with regard to systems to counter ballistic missiles other than strategic ballistic missiles, it has no plans:

(a) before April 1999 to test, against a ballistic target-missile, land-based, sea-based or air-based interceptor missiles whose velocity exceeds 3 km/sec over any part of their flight trajectory;

(b) to develop such systems with interceptor missiles whose velocity over any part of their flight trajectory exceeds 5.5 km/sec for land-based and air-based systems or 4.5 km/sec for sea-based systems;

(c) to test such systems against ballistic target-missiles with multiple independently targetable reentry vehicles deployed or planned to be deployed on strategic ballistic missiles.

*The Republic of Belarus, the Republic of Kazakhstan, the Russian Federation and Ukraine each issued the same statement.

Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their destruction

10 April 1972

The States Parties to this Convention,

Determined to act with a view to achieving effective progress towards general and complete disarmament, including the prohibition and elimination of all types of weapons of mass destruction, and convinced that the prohibition of the development, production and stockpiling of chemical and bacteriological (biological) weapons and their elimination, through effective measures, will facilitate the achievement of general and complete disarmament under strict and effective international control,

Recognising the important significant of the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and the Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, and conscious also of the contribution which the said Protocol has already made, and continues to make, to mitigating the horrors of war,

Reaffirming their adherence to the principles and objectives of that Protocol and calling upon all States to comply strictly with them,

Recalling that the General Assembly of the United Nations has repeatedly condemed all actions contrary to the principles and objectives of the Geneva Protocol of 17 June 1925,

Desiring to contribute to the strengthening of confidence between peoples and the general improvement of the international atmosphere,

Desiring also to contribute to the realisation of the purposes and principles of the Charter of the United Nations,

Convinced of the importance and urgency of eliminating from the arsenals of States, through effective measure, such dangerous weapons of mass destruction as those using chemical or bacteriological (biological) agents,

Recognising that an agreement on the prohibition of bacteriological (biological) and toxin weapons represents a first possible step towards the achievement *of* agreement on effective measures also for the prohibition of the development, production and stockpiling of chemical weapons, and determined to continue negotiations to that end,

Determined, for the sake of all mankind, to exclude completely the possibility of bacteriological (biological) agents, and toxins being used as weapons,

Convinced that such use would be repugnant to the conscience of mankind and that no effort should be spared to minimise this risk,

Have agreed as follows:

Article I

Each State Party to this Convention undertakes never in any circumstance to develop, produce, stockpile or otherwise acquire or retain:

1. microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes;
2. weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict.

Article II

Each State Party to this Convention undertakes to destroy, or to divert to peacful purposes, as soon as possible but not later than nine months after the entry into force of the Convention, all agents, toxins, weapons equipment and means of delivery specified in Article I of the Convention, which are in its possession or under its jurisdiction or control. In implementing the provisions of this Article all necessary safety precautions shall be observed to protect populations and the environment.

Article III

Each State Party to this Convention undertakes not to transfer to any recipient whatsoever, directly or indirectly, and not in any way assist, encourage, or induce any State, group of States or international organisations to manufacture or otherwise acquire any of the agents, toxins, weapons, equipment or means of delivery specified in Article I of the Convention.

Article IV

Each State Party to this Convention shall, in accordance with its constitutional processes, take any necessary measures to prohibit and prevent the development, production stockpiling, acquisition or retention of the agents, toxins, weapons, equipment and means of delivery specified in Article I of the Convention, within the territory of such State, under its jurisdiction or under its control anywhere.

Article V

The States Parties to this Convention undertake to consult one another and to co-operate in solving any problems which may arise in relation to the objective of, or in the application of the provisions of, the Convention. Consultation and co-operation pursuant to this Article may also be undertaken through appropriate international procedures within the framework of the United Nations and in accordance with its Charter.

Article VI

1. Any State Party to this Convention which finds that any other State Party is acting in breach of obligations deriving from the provision of the Convention may lodge a complaint with the Security Council of the United Nations. Such a complaint should include all possible evidence confirming its validity, as well as a request for its consideration by the Security Council.
2. Each State Party to this Convention undertakes to co-operate in carrying out any investigation which the Security Council may initiate, in accordance with the provisions of the Charter of the United Nations, on the basis of the complaint received by the Council. The Security Council shall inform the States Parties to the Convention of the results of the investigation.

Article VII

Each State Party to this Convention undertakes to provide or support assistance, in accordance with the United Nations Charter, to any Party to the Convention which so requests, if the Security Council decides that such Party has been exposed to danger as a result of violation of the Convention.

Article VIII

Nothing in this Convention shall be interpreted as in any way limiting or detracting from the obligations assumed by any State under the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925.

Article IX

Each State Party to this Convention affirms the recognised objective of effective prohibition of chemical weapons and, to this end, undertakes to continue negotiations in good faith with a view to reaching early agreement in effective measures for the prohibition of their development, production and stockpiling and for their destruction, and on appropriate measures concerning equipment and means of delivery specifically designed for the production or use of chemical agents for weapons purposes.

Article X

1. The States Parties to this Convention undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the use of bacteriological (biological) agents and toxins for peaceful purposes. Parties to the Convention in a position to do so shall also co-operate in contributing individually or together with other States or international organisations to the further development and application of scientific discoveries in the field of bacteriology (biology) for the prevention of disease, or for other peaceful purposes.
2. This Convention shall be implemented in a manner designed to avoid hampering the economic or technological development of States Parties to the Convention or international co-operation in the field of peaceful bacteriological (biological) activities, including the international exchange of bacteriological (biological) agents and toxins and equipment for the processing, use or production of bacteriological (biological) agents and toxins for peaceful purposes in accordance with the provision of the Convention.

Article XI

Any State Party may propose amendments to this Convention. Amendments shall enter into force for each State Party accepting the amendments upon their acceptance by a majority of the States Parties to the Convention and thereafter for each remaining State Party on the date of acceptance by it.

Article XII

Five years after the entry into force of this Convention, or earlier if it is requested by a majority of Parties to the Convention by submitting a proposal to this effect to the Depositary Governments, a conference of States Parties to the Convention shall be held at Geneva, Switzerland, to view the operation of the Convention, with a view to assuring that the purposes of the preamble and the provisions of the Convention, including the provisions concerning negotiations on chemical weapons, are being realised. Such review shall take into account any new scientific and technological developments relevant to the Convention.

Article XIII

1. This Convention shall be of unlimited duration.
2. Each State Party to this Convention shall in exercising its national sovereignty have the right to withdraw from the Convention if it decides that extraordinary events, related to the subject matter of the Convention, have jeopardised the supreme interests of its country. It shall give notice of such withdrawal to all other States Parties to the Convention and to the United Nations Security Council three months in advanced. Such notice shall include a statement of the extraordinary events it regards as having jeopardised its supreme interests.

Article XIV

1. This Convention shall be open to all State for signature. Any State which does not sign the Convention before its entry into force in accordance with paragraph 3 of this Article may accede to it at all time.
2. This Convention shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United Kingdom of Great Britain and Northern Ireland, the Union of Soviet Socialist Republics and the United States of America, which are hereby designated the Depositary Governments.
3. This Convention shall enter into force after the deposit of instruments of ratification by twenty-two Governments, including the Governments designated as Depositaries of the Convention.
4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Convention, it shall enter into force on the date **of** the deposit of their instruments of ratification or accession.
5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession and the date of the entry into force of this Convention, and of the receipt of other notices.
6. This Convention shall be registered by the Depositary Governments pursuant of Article 102 of the Charter of the United Nations.

Article XV

This Convention, the English, Russian, French, Spanish and Chinese texts of which are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of the Convention shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

Agreement Between the United States of America and the Union of Soviet Socialist Republics on the Prevention of Nuclear War

22 June 1973

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Guided by the objectives of strengthening world peace and international security,

Conscious that nuclear war would have devastating consequences for mankind,

Proceeding from the desire to bring about conditions in which the danger of an outbreak of nuclear war anywhere in the world would be reduced and ultimately eliminated,

Proceeding from their obligations under the Charter of the United Nations regarding the maintenance of peace, refraining from the threat or use of force, and the avoidance of war, and in conformity with the agreements to which either Party has subscribed,

Proceeding from the Basic Principles of Relations between the United States of America and the Union of Soviet Socialist Republics signed in Moscow on May 29, 1972,

Reaffirming that the development of relations between the United States of America and the Union of Soviet Socialist Republics is not directed against other countries and their interests,

Have agreed as follows:

Article I

The United States and the Soviet Union agree that an objective of their policies is to remove the danger of nuclear war and of the use of nuclear weapons.

Accordingly, the Parties agree that they will act in such a manner as to prevent the development of situations capable of causing a dangerous exacerbation of their relations, as to avoid military confrontations, and as to exclude the outbreak of nuclear war between them and between either of the Parties and other countries.

Article II

The Parties agree, in accordance with Article I and to realize the objective stated in that Article, to proceed from the premise that each Party will refrain from the threat or use of force against the other Party, against the allies of the other Party and against other countries, in circumstances which may endanger international peace and security. The Parties agree that they will be guided by these considerations in the formulation of their foreign policies and in their actions in the field of international relations.

Article III

The Parties undertake to develop their relations with each other and with other countries in a way consistent with the purposes of this Agreement.

Article IV

If at any time relations between the Parties or between either Party and other countries appear to involve the risk of a nuclear conflict, or if relations between countries not parties to this Agreement appear to involve the risk of nuclear war between the United States of America and the Union of Soviet Socialist Republics or between either Party and other countries, the United States and the Soviet Union, acting in accordance with the provisions of this Agreement, shall immediately enter into urgent consultations with each other and make every effort to avert this risk.

Article V

Each Party shall be free to inform the Security Council of the United Nations, the Secretary General of the United Nations and the Governments of allied or other countries of the progress and outcome of consultations initiated in accordance with Article IV of this Agreement.

Article VI

Nothing in this Agreement shall affect of impair:

(a) the inherent right of individual or collective self-defense as envisaged by Article 51 of the Charter of the United Nations,

(b)the provisions of the Charter of the United Nations, including those relating to the maintenance or restoration of international peace and security, and

(c) the obligations undertaken by either Party towards its allies or other countries in treaties, agreements, and other appropriate documents.

Article VII

This Agreement shall be of unlimited duration.

Article VIII

This Agreement shall enter into force upon signature

DONE at Washington on June 22, 1973, in two copies, each in the English and Russian languages, both texts being equally authentic.

FOR THE UNITED STATES OF AMERICA:
RICHARD NIXON
President of the United States of America

FOR THE UNION OF SOVIET SOCIALIST REPUBLICS:
L I BREZHNEV
General Secretary of the Central Committee, CPSU

Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Underground Nuclear Weapon Tests

3 July 1974

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Declaring their intention to achieve at the earliest possible date the cessation of the nuclear arms race and to take effective measures toward reductions in strategic arms, nuclear disarmament, and general and complete disarmament under strict and effective international control,

Recalling the determination expressed by the Parties to the 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water in its Preamble to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time, and to continue negotiations to this end,

Noting that the adoption of measures for the further limitation of underground nuclear weapon tests would contribute to the achievement of these objectives and would meet the interests of strengthening peace and the further relaxation of international tension,

Reaffirming their adherence to the objectives and principles of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water and of the Treaty on the Non-Proliferation of Nuclear Weapons,

Have agreed as follows:

Article I

1. Each Party undertakes to prohibit, to prevent, and not to carry out any underground nuclear weapon test having a yield exceeding 150 kilotons at any place under its jurisdiction or control, beginning March 31, 1976.
2. Each Party shall limit the number of its underground nuclear weapon tests to a minimum.
3. The Parties shall continue their negotiations with a view toward achieving a solution to the problem of the cessation of all underground nuclear weapon tests.

Article II

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with the generally recognized principles of international law.
2. Each Party undertakes not to interfere with the national technical means of verification of the other Party in accordance with paragraph 1 of this Article.
3. To promote the objectives and implementation of the provisions of this Treaty the Parties shall, as necessary, consult with each other, make inquiries and furnish information in response to such inquiries.

Article III

The provisions of this Treaty do not extend to underground nuclear explosions carried out by the Parties for peaceful purposes. Underground nuclear explosions for peaceful purposes shall be governed by an agreement which is to be negotiated and concluded by the Parties at the earliest possible time.

Article IV

This Treaty shall be subject to ratification in accordance with the constitutional procedures of each Party. This Treaty shall enter into force on the day of the exchange of instruments of ratification.

Article V

1. This Treaty shall remain in force for a period of five years. Unless replaced earlier by an agreement in implementation of the objective specified in paragraph 3 of Article I of this Treaty, it shall be extended for successive five-year periods unless either Party notifies the other of its termination no later than six months prior to the expiration of the Treaty. Before the expiration of this period the Parties may, as necessary, hold consultations to consider the situation relevant to the substance of this Treaty and to introduce possible amendments to the text of the Treaty.
2. Each Party shall, in exercising its national sovereignty, have the right to withdraw from this Treaty if it decides that extraordinary events related to the subject matter of this Treaty have jeopardized its supreme interests. It shall give notice of its decision to the other Party six months prior to withdrawal from this Treaty. Such notice shall include a statement of the extraordinary events the notifying Party regards as having jeopardized its supreme interests.
3. This Treaty shall be registered pursuant to Article 102 of the Charter of the United Nations.

Protocol to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Underground Nuclear Weapon Tests

3 July 1974

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Having agreed to limit underground nuclear weapon tests,

Have agreed as follows:

1. For the Purpose of ensuring verification of compliance with the obligations of the Parties under the Treaty by national technical means, the Parties shall, on the basis of reciprocity, exchange the following data:

a. The geographic coordinates of the boundaries of each test site and of the boundaries of the geophysically distinct testing areas therein.

b. Information on the geology of the testing areas of the sites (the rock characteristics of geological formations and the basic physical properties of the rock, i.e., density, seismic velocity, water saturation, porosity and the depth of water table).

c. The geographic co-ordinates of underground nuclear weapon tests, after they have been conducted.

d. Yield, date, time, depth and coordinates for two nuclear weapon tests for calibration purposes from each geophysically distinct testing area where underground nuclear weapon tests have been and are to be conducted. In this connection the yield of such explosions for calibration purposes should be as near as possible to the limit defined in Article I of the Treaty and not less than one-tenth of that limit. In the case of testing areas where data are not available on two tests for calibration purposes, the data pertaining to one such test shall be exchanged, if available, and the data pertaining to the second test shall be exchanged as soon as possible after the second test having a yield in the above-mentioned range. The provisions of this Protocol shall not require the Parties to conduct tests solely for calibration purposes.

2. The Parties agree that the exchange data pursuant to subparagraphs a, b, and d of paragraph 1 shall be carried out simultaneouslywith the exchange of instruments of ratification of the Treaty, as provided in Article IV of the Treaty, having in mind that the Parties shall, on the basis of reciprocity, afford each other the opportunity to familiarize themselves with these data before the exchange of instruments of ratification.

3. Should a Party specify a new test site or testing area after the entry into force of the Treaty, the data called for by subparagraphs a and b of paragraph 1 shall be transmitted to the other Party in advance of use of that site area. The data called for by subparagraph 1 shall also be transmitted in advance of use of that site or area if they are available; if they are not available, they shall be transmitted as soon as possible after they have been obtained by the transmitting Party.

4. The Parties agree that the test sites of each Party shall be located at places under its jurisdiction or control and that all nuclear weapon tests shall be conducted solely within the testing areas specified in accordance with paragraph 1.

5. For the purposes of the Treaty, all underground nuclear explosions at the specified sites shall be considered nuclear weapon tests and shall be subject to all the provisions of the Treaty relating to nuclear weapon tests. The provisions of Article III of the Treaty apply to all underground nuclear explosions conducted outside of the specified test sites, and only to such explosions.

This Protocol shall be considered an integral part of the Treaty.

Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitations of Strategic Offensive Arms (SALT 2)

18 June 1979

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Conscious that nuclear war would have devastating consequences for all mankind,

Proceeding from the Basic Principles of Relations Between the United States of America and the Union of Soviet Socialist Republics of 29 May 1972,

Attaching particular significance to the limitation of strategic arms and determined to continue their efforts begun with the Treaty on the Limitation of Anti-Ballistic Missile Systems and the Interim Agreement on Certain Measures with respect to the Limitations of Strategic Offensive Arms, of 26 May 1972,

Convinced that the additional measures limiting strategic offensive arms provided for in this Treaty will contribute to the improvement of relations between the Parties, help to reduce the risk of outbreak of nuclear war and strengthen international peace and security,

Mindful of their obligations under Article VI of the Treaty on the Non-Proliferation of Nuclear Weapons,

Guided by the principle of equality and equal security,

Recognizing that the strengthening of strategic stability meets the interests of the Parties and the interests of international security,

Reaffirming their desire to take measures for further limitation and for the further reduction of strategic arms, having in mind the goal of achieving general and complete disarmament,

Declaring their intention to undertake in the near future negotiations further to limit and further to reduce strategic offensive arms,

Have agreed as follows:

Article I

Each Party undertakes, in accordance with the provisions of this Treaty, to limit strategic offensive arms quantitatively and qualitatively, to exercise restraint in the development of new types of strategic offensive arms, and to adopt other measures provided for in this Treaty.

Article II

For the purposes of this Treaty:

1. Intercontinental and Ballistic Missile (ICBM) launchers are land-based launchers of ballistic missiles capable of a range in excess of the shortest distance between the northeastern border of the continental part of the territory of the United States of America and the northwestern border of the continental part of the territory of the Union of Soviet Socialist Republics, that is, a range in excess of 5,500 kilometers.

First Agreed Statement. The term 'intercontinental ballistic missile launchers', as defined in paragraph 1 of Article II of the Treaty, includes all launchers which have been developed and tested for launching ICBMs. If a launcher has been developed and tested for launching an ICBM, all launchers of that type shall be considered to have been developed and tested for launching ICBMs.

First Common Understanding. If a launcher contains or launches an ICBM, that launcher shall be considered to have been developed and tested for launching ICBMs.

Second Common Understanding. If a launcher has been developed and tested for launching an ICBM, all launchers of that type, except for ICBM test and training launchers, shall be included in the aggregate numbers of strategic offensive arms provided for in Article III of the Treaty, pursuant to the provisions of Article VI of the Treaty.

Third Common Understanding. The one hundred and seventy-seven former Atlas and Titan I ICBM launchers of the United States of America, which are no longer operational and are partially dismantled, shall not be considered as subject to the limitations provided for in the Treaty.

Second Agreed Statement. After the date on which the Protocol ceases to be in force, mobile ICBM launchers shall be subject to the relevant limitations provided for in the Treaty which are applicable to ICBM launchers, unless the Parties agree that mobile ICBM launchers shall not be deployed after that date.

2. Submarine-Launched Ballistic Missile (SLBM) launchers are launchers of ballistic missiles installed on any nuclear-powered submarine or launchers of modern ballistic missiles installed on any submarine, regardless of its type.

Agreed Statement. Modern submarine-launched ballistic missiles are: for the United States of America, missiles installed in nuclear-powered submarines; for the Union of Soviet Socialist Republics, missiles of the type installed in nuclear-powered submarines made operational since 1965; and for both Parties, submarine-launched ballistic missiles first flight-tested since 1965 and installed in any submarine, regardless of its type.

3. Heavy bombers are considered to be:

(a) currently, for the United States of America, bombers of the B-52 and B-1 types, and for the Union of Soviet Socialist Republics, bombers of the Tupolev-95 and Myasishchev types;

(b) in the future, types of bombers which can carry out the mission of a heavy bomber in a manner similar to or superior to that of bombers listed in subparagraph (a) above;

(c) types of bombers equipped for cruise missiles capable of a range in excess of 600 kilometers; and

(d) types of bombers equipped for ASBMs.

First Agreed Statement. The term 'bombers' as used in paragraph 3 of Article II and other provisions of the Treaty, means airplanes of types initially constructed to be equipped for bombs or missiles.

Second Agreed Statement. The Parties shall notify each other on a case-by-case basis in the Standing Consultative Commission of inclusion of types of bombers as heavy bombers pursuant to the provisions of paragraph 3 of Article II of the Treaty; in this connection the Parties shall hold consultations, as appropriate, consistent with the provisions of paragraph 2 of Article XVII of the Treaty.

Third Agreed Statement. The criteria the Parties shall use to make case-by-case determinations of which types of bombers in the future can carry out the mission of a heavy bomber in a manner similar or superior to that of current heavy bombers, as referred to in subparagraph 3(b) of Article II of the Treaty, shall be agreed upon in the Standing Consultative Commission.

Fourth Agreed Statement. Having agreed that every bomber of a type included in paragraph 3 of Article II of the Treaty is to be considered a heavy bomber, the Parties further agree that:

(a) airplanes which otherwise would be bombers of a heavy bomber type shall not be considered to be bombers of a heavy bomber type if they have functionally related observable differences which indicate that they cannot perform the mission of a heavy bomber;

(b) airplanes which otherwise would be bombers of a type equipped for cruise missiles capable of a range in excess of 600 kilometers shall not be considered to be bombers of a type equipped for cruise missiles capable of a range in excess of 600 kilometers if they have functionally related observable differences which indicate that they cannot perform the mission of a bomber equipped for cruise missiles capable of a range in excess of 600 kilometers, except that heavy bombers of current types, as designated in subparagraph 3(a) of Article II of the Treaty, which otherwise would be of a type equipped for cruise missiles capable of a range in excess of 600 kilometers shall not be considered to be heavy bombers of a type equipped for cruise missiles capable of a range in excess of 600 kilometers if they are distinguishable on the basis of externally observable differences from heavy bombers of a type equipped for cruise missiles capable of a range in excess of 600 kilometers; and

(c) airplanes which otherwise would be bombers of a type equipped for ASBMs shall not be considered to be bombers of a type equipped for ASBMs if they have functionally related observable differences which indicate that they cannot perform the mission of a bomber equipped for ASBMs, except that heavy bombers of current types, as designated in subparagraph 3(a) of Article II of the Treaty, which otherwise would be of a type equipped for ASBMs shall not be considered to be heavy bombers of a type equipped for ASBMs if they are distinguishable on the basis of externally observable differences from heavy bombers of a type equipped for ASBMs.

First Common Understanding. Functionally related observable differences are differences in the observable features of airplanes which indicate whether or not these airplanes can perform the mission of a heavy bomber, or whether or not they can perform the mission of a bomber equipped for cruise missiles capable of a range in excess of 600 kilometers or whether or not they can perform the mission of a bomber equipped for ASBMs. Functionally related observable differences shall be verifiable by national technical means. To this end, the Parties may take, as appropriate, co-operative measures contributing to the effectiveness of verification by national technical means.

Fifth Agreed Statement. Tupolev-142 airplanes in their current configuration, that is, in the configuration for anti-submarine warfare, are considered to be airplanes of a type different from types of heavy bombers referred to in subparagraph 3(a) of Article II of the Treaty and not subject to the Fourth Agreed Statement to paragraph 3 of Article II of the Treaty. This Agreed Statement does not preclude the improvement of Tupolev-142 airplanes as an anti-submarine system, and does not prejudice or set a precedent for designation in the future of types of airplanes as heavy bombers pursuant to subparagraph 3(b) of Article II of the Treaty or for application on the Fourth Agreed Statement to paragraph 3 of Article II of the Treaty to such airplanes.

Second Common Understanding. Not later than six months after entry into force of the Treaty the Union of Soviet Socialist Republics will give its thirty-one Myasishchev airplanes used as tankers in existence as of the date of signature of the Treaty functionally related observable differences which indicate that they cannot perform the mission of a heavy bomber.

Third Common Understanding. The designations by the United States of America and by the Union of Soviet Socialist Republics for heavy bombers referred to in subparagraph 3(a) of Article II of the Treaty correspond in the following manner:

Heavy bombers of the types designated by the United States of America as the B-52 and the B-1 are known to the Union of Soviet Socialist Republics by the same designations;

Heavy bombers of the type designated by the Union of Soviet Socialist Republics as the Tupolev-95 are known to the United States of America as heavy bombers of the Bear type; and

Heavy bombers of the type designated by the Union of Soviet Socialist Republics as the Myasishchev are known to the United States of America as heavy bombers of the Bison type.

4. Air-to-Surface Ballistic Missiles (ASBMs) are any such missiles capable of a range in excess of 600 kilometers and installed in an aircraft or on its external mountings.

5. Launchers of ICBMs and SLBMs equipped with Multiple Independently targetable Re-entry Vehicles (MIRVs) are launchers of the types developed and tested for launching ICBMs or SLBMs equipped with MIRVs.

First Agreed Statement. If a launcher has been developed and tested for launching an ICBM or an SLBM equipped with MIRVs, all launchers of that type shall be considered to have been developed and tested for launching ICBMs or SLBMs equipped with MIRVs.

First Common Understanding. If a launcher contains or launches an ICBM or an SLBM equipped with MIRVs, that launcher shall be considered to have been developed and tested for launching ICBMs or SLBMs equipped with MIRVs.

Second Common Understanding. If a launcher has been developed and tested for launching an ICBM or an SLBM equipped with MIRVs, all launchers of that type, except for ICBM and SLBM test and training launchers, shall be included in the corresponding aggregate numbers provided for in Article V of the Treaty, pursuant to the provisions of Article VI of the Treaty.

Second Agreed Statement. ICBMs and SLBMs equipped with MIRVs are ICBMs and SLBMs of the types which have been flight-tested with two or more independently targetable re-entry vehicles, regardless of whether or not they have also been flight-tested with a single re-entry vehicle or with multiple re-entry vehicles which are not independently targetable. As of the date of signature of the Treatv, such ICBMs and SLBMs are: for the United States of America, Minuteman III ICBMs, Poseidon

C-3 SLBMs, and Trident C-4 SLBMs; and for the Union of Soviet Socialist Republics, RS-16, RS-18, RS-20 ICBMs and RSM-50 SLBMs.

Each Party will notify the other Party in the Standing Consultative Commission on a case-by-case basis of the designation of the one new type of light ICBM, if equipped with MIRVs, permitted pursuant to paragraph 9 of Article IV of the Treaty when first flight-tested: of designations of additional types of SLBMs equipped with MIRVs when first installed on a submarine; and of designations of types of ASBMs equipped with MIRVs when first flight-tested.

Third Common Understanding. The designations by the United States of America and by the Union of Soviet Socialist Republics for ICBMs and SLBMs equipped with MIRVs correspond in the following manner:

Missiles of the type designated by the United States of America as the Minuteman III and known to the Union of Soviet Socialist Republics by the same designation, a light ICBM that has been flight-tested with multiple independently targetable re-entry vehicles;

Missiles of the type designated by the United States of America as the Poseidon C-3 and known to the Union of Soviet Socialist Republics by the same designation, an SLBM that was first flight-tested in 1968 and that has been flight-tested with multiple independently targetable re-entry vehicles;

Missiles of the type designated by the United States of America as the Trident C-4 and known to the Union of Soviet Socialist Republics by the same designation, an SLBM that was first flight-tested in 1977 and that has been flight-tested with multiple independently targetable re-entry vehicles;

Missiles of the type designated by the Union of Soviet Socialist Republics as the R-16 and known to the United States of America as the SS-17, a light ICBM that has been flight-tested with a single re-entry vehicle and with multiple independently targetable re-entry vehicles;

Missiles of the type designated by the Union of Soviet Socialist Republics as the RS-18 and known to the United States of America as the SS-19, the heaviest in terms of launch-weight and throw-weight of light ICBMs, which has been flight-tested with a single re-entry vehicle and with multiple independently targetable re-entry vehicles;

Missiles of the type designated by the Union of Soviet Socialist Republics as the RS-20 and known to the United States of America as the SS-18, the heaviest in terms of launch-weight and throw-weight of heavy ICBMs, which has been flight-tested with a single re-entry vehicle and with multiple independently targetable re-entry vehicles;

Missiles of the type designated by the Union of Soviet Socialist Republics as the RSM-50 and known to the United States of America as the SS-N-18, an SLBM that has been flight-tested with a single re-entry vehicle and with multiple independently targetable re-entry vehicles.

Third Agreed Statement. Re-entry vehicles are independently targetable:

(a) if, after separation from the booster, manoeuvring and targeting of the re-entry vehicles to separate aim points along trajectories which are unrelated to each other are accomplished by means of devices which are installed in a self-contained dispensing mechanism or on the re-entry vehicles, and which are based on the use of electronic or other computers in combination with devices using jet engines, including rocket engines, or aerodynamic systems;

(b) if manoeuvring and targeting of the re-entry vehicles to separate aim points along trajectories which are unrelated to each other are accomplished by means of other devices which may be developed in the future.

Fourth Common Understanding. For the purposes of this Treaty all ICBM launchers in the Derazhnya and Pervomaysk areas in the Union of Soviet Socialist Republics are included in the aggregate numbers provided for in Article V of the Treaty.

Fifth Common Understanding. If ICBM or SLBM launchers are converted, constructed or undergo significant changes to their principal observable structural design features after entry into force of the Treaty, any such launchers which are launchers of missiles equipped with MIRVs shall be distinguishable from launchers of missiles not equipped with MIRVs, and any such launchers which are launchers of missiles not equipped with MIRVs shall be distinguishable from launchers of missiles equipped with MIRVs, on the basis of externally observable design features of the launchers. Submarines with launchers of SLBMs equipped with MIRVs shall be distinguishable from submarines with launchers of SLBMs not equipped with MIRVs on the basis of externally observable design features of the submarines.

This Common Understanding does not require changes to launchers conversion or construction programs or to programs including significant changes to the principal observable structural design features of launchers, underway as of the date of signature of the Treaty.

6. ASBMs equipped with MIRVs are ASBMs of the types which have been flight-tested with MIRVs.

First Agreed Statement. ASBMs of the types which have been flight-tested with MIRVs are all ASBMs of the types which have been flight-tested with two or more independently targetable re-entry vehicles, regardless of whether or not they have also been flight-tested with a single re-entry vehicle or with multiple re-entry vehicles which are not independently targetable.

Second Agreed Statement. Re-entry vehicles are independently targetable:

(a) if, after separation from the booster, manoeuvring and targeting of the re-entry vehicles to separate aim points along trajectories which are unrelated to each other are accomplished by means of devices which are installed in a self-contained dispensing mechanism or on the re-entry vehicles, and which are based on the use of electronic or other computers in combination with devices using jet engines, including rocket engines, or aerodynamic systems;

(b) if manoeuvring and targeting of the re-entry vehicles to separate aim point along trajectories which are unrelated to each other are accomplished by means of other devices which may be developed in the future.

7. Heavy ICBMs are ICBMs which have a launch-weight greater or a throw-weight greater than that of the heaviest, in terms of either launch-weight or throw-weight, respectively, of the light ICBMs deployed by either Party as of the date of signature of this Treaty.

First Agreed Statement. The launch-weight of an ICBM is the weight of the fully loaded missile itself at the time of launch.

Second Agreed Statement. The throw-weight of an ICBM is the sum of the weight of:

(a) its re-entry vehicle or re-entry vehicles:

(b) any self-contained dispensing mechanism or other appropriate devices for targeting one re-entry vehicle, or for releasing or for dispensing and targeting two or more re-entry vehicles; and

(c) its penetration aids, including devices for their release.

Common Understanding. The term 'other appropriate devices', as used in the definition of the throw-weight of an ICBM in the Second Agreed Statement to paragraph 7 of Article II of the Treaty, means any devices for dispensing and targeting two or more re-entry vehicles; and any devices for releasing two or more re-entry vehicles or for targeting one re-entry vehicle, which cannot provide their re-entry vehicles or re-entry vehicle with additional velocity of more than 1,000 metres per second.

8. Cruise missiles are unmanned, self-propelled, guided, weapon-delivery vehicles which sustain flight through the use of aerodynamic lift over most of their flight path and which are flight-tested from or deployed on aircraft, that is, air-launched cruise missiles, or such vehicles which are referred to as cruise missiles in subparagraph 1(b) of Article IX.

First Agreed Statement. If a cruise missile is capable of a range in excess of 600 kilometers, all cruise missiles of that type shall be considered to be cruise missiles capable of a range in excess of 600 kilometers.

First Common Understanding. If a cruise missile has been flight-tested to a range in excess of 600 kilometers, it shall be considered to be a cruise missile capable of a range in excess of 600 kilometers.

Second Common Understanding. Cruise missiles not capable of a range in excess of 600 kilometers shall not be considered to be of a type capable of a range in excess of 600 kilometers if they are distinguishable on the basis of externally observable design features from cruise missiles of types capable of a range in excess of 600 kilometers.

Second Agreed Statement. The range of which a cruise missile is capable is the maximum distance which can be covered by the missile in its standard design mode flying until fuel exhaustion, determined by projecting its flight path onto the Earth's sphere from the point of launch to the point of impact.

Third Agreed Statement. If an unmanned, self-propelled, guided vehicle which sustains flight through the use of aerodynamic lift over most of its flight path has been flight-tested or deployed for weapon-delivery, all vehicles of that type shall be considered to be weapon-delivery vehicles.

Third Common Understanding. Unmanned, self-propelled, guided vehicles which sustain flight through the use of aerodynamic lift over most of their flight path and are not weapon-delivery vehicles, that is, unarmed, pilotless, guided vehicles, shall not be considered to be cruise missiles if such vehicles are distinguishable from cruise missiles on the basis of externally observable design features.

Fourth Common Understanding. Neither Party shall convert unarmed, pilotless, guided vehicles into cruise missiles capable of a range in excess of 600 kilometers, nor shall either Party convert cruise missiles capable of a range in excess of 600 kilometers into unarmed, pilotless, guided vehicles.

Fifth Common Understanding. Neither Party has plans during the term of the Treaty to flight-test from or deploy on aircraft unarmed, pilotless, guided vehicles which are capable of a range in excess of 600 kilometers. In the future, should a Party have such plans, that Party will provide notification thereof to the other Party well in advance of such flight-testing or deployment. This Common Understanding does not apply to target drones.

Article III

1. Upon entry into force of this Treaty, each Party undertakes to limit ICBM launchers, SLBM launchers, heavy bombers, and ASBMs to an aggregate number not to exceed 2,400.

2. Each Party undertakes to limit, from 1 January 1981, strategic offensive arms referred to in paragraph 1 of this Article to an aggregate number not to exceed 2,250, and to initiate reductions of those arms which as of that date would be in excess of this aggregate number.

3. Within the aggregate numbers provided for in paragraphs 1 and 2 of this Article and subject to the provisions of this Treaty, each Party has the right to determine the composition of these aggregates.

4. For each bomber of a type equipped for ASBMs, the aggregate numbers provided for in paragraphs 1 and 2 of this Article shall include the maximum number of such missiles for which a bomber of that type is equipped for one operational mission.

5. A heavy bomber equipped only for ASBMs shall not itself be included in the aggregate numbers provided for in paragraphs 1 and 2 of this Article.

6. Reductions of the numbers of strategic offensive arms required to comply with the provisions of paragraphs 1 and 2 of this Article shall be carried out as provided for in Article XI.

Article IV

1. Each Party undertakes not to start construction of additional fixed ICBM launchers.

2. Each Party undertakes not to relocate fixed ICBM launchers.

3. Each Party undertakes not to convert launchers of light ICBMs, or of ICBMs of older types deployed prior to 1964, into launchers of heavy ICBMs of types deployed after that time.

4. Each Party undertakes in the process of modernization and replacement of ICBM silo launchers not to increase the original internal volume of an ICBM silo launcher by more than thirty-two per cent. Within this limit each Party has the right to determine whether such an increase will be made through an increase in the original diameter or in the original depth of an ICBM silo launchers, or in both of these dimensions.

Agreed Statement. The word 'original' in paragraph 4 of Article IV of the Treaty refers to the internal dimensions of an ICBM silo launcher, including its internal volume, as of 26 May 1972, or as of the date on which such launcher becomes operational, whichever is later.

Common Understanding. The obligations provided for in paragraph 4 of Article IV of the Treaty and in the Agreed Statement thereto mean that the original diameter or the original depth of an ICBM silo launcher may not be increased by an amount greater than that which would result in an increase in the original internal volume of the ICBM silo launcher by thiry-two per cent solely through an increase in one of these dimensions.

5. Each party undertakes:

(a) not to supply ICBM launcher deployment areas with intercontinental missiles in excess of a number consistent with normal deployment, maintenance, training, and replacement requirements;

(b) not to provide storage facilities for or to store ICBMs in excess of normal deployment requirements at launch sites of ICBM launchers;

(c) not to develop, test, or deploy systems for rapid reload of ICBM launchers.

Agreed Statement. The term 'normal deployment requirements', as used in paragraph 5 of Article IV of the Treaty, means the deployment of one missile at each ICBM launcher.

6. Subject to the provisions of this Treaty, each Party undertakes not to have under construction at any time strategic offensive arms referred to in paragraph 1 of Article III in excess of numbers consistent with a normal construction schedule.

Common Understanding. A normal construction schedule, in paragraph 6 of Article IV of the Treaty, is understood to be one consistent with the past or present construction practices of each Party.

7. Each Party undertakes not to develop, test, or deploy ICBMs which have a launch-weight greater or a throw-weight greater than that of the heaviest, in terms of either launch-weight or throw-weight, respectively, of the heavy ICBMs deployed by either Party as of the date of signature of this Treaty.

First Agreed Statement. The launch-weight of an ICBM is the weight of the fully loaded missile itself at the time of launch.

Second Agreed Statement. The throw-weight of an ICBM is the sum of the weight of:

(a) its re-entry vehicle or re-entry vehicles;

(b) any self-contained dispensing mechanisms or other appropriate devices for targeting one re-entry vehicle, or for releasing or for dispensing and targeting two or more re-entry vehicles; and

(c) its penetration aids, including devices for their release.

Common Understanding. The term 'other appropriate devices', as used in the definition of the throw-weight of an ICBM in the Second Agreed Statement to paragraph 7 of Article IV of the Treaty, means any devices for dispensing and targeting two or more re-entry vehicles; and any devices for releasing two or more re-entry vehicles or for targeting one re-entry vehicle, which cannot provide their re-entry vehicles or re-entry vehicle with additional velocity of more than 1,000 metres per second.

8. Each Party undertakes no to convert land-based launchers of ballistic missiles which are not ICBMs into launchers for launching ICBMs, and not to test them for this purpose

Common Understanding. During the term of the Treaty, the Union of Soviet Socialist Republics will not produce, test, or deploy ICBMs of the type designated by the Union of Soviet Socialist Republics as the RS-14 and known to the United States of America as the SS-16, a light ICBM first flight-tested after 1970 and flight-tested only with a single re-entry vehicle; this Common Understanding also means that the Union of Soviet Socialist Republics will not produce the third stage of that missile, the re-entry vehicle of that missile, or the appropriate device for targeting the re-entry vehicle of that missile.

9. Each Party undertakes not to flight-test or deploy new types of ICBMs, that is, types of ICBMs not flight-tested as of 1 May 1979, except that each Party may flight-test and deploy one new type of light ICBM.

First Agreed Statement. The term 'new types of ICBMs' as used in paragraph 9 of Article IV of the Treaty, refers to any ICBM which is different from those ICBMs flight-tested as of 1 May 1979 in any one or more of the following respects:

(a) the number of stages, the length, the largest diameter, the launch-weight, or the throw-weight, of the missile;

(b) the type of propellant (that is, liquid or solid) of any of its stages.

First Common Understanding. As used in the First Agreed Statement to paragraph 9 of Article IV of the Treaty, the term 'different', referring to the length, the diameter, the launch-weight, and the throw-weight, of the missile, means a difference in excess of five per cent.

Second Agreed Statement. Every ICBM of the one new type of light ICBM permitted to each Party pursuant to paragraph 9 of Article IV of the Treaty shall have the same number of stages and the same type of propellant (that is, liquid or solid) of each stage as the first ICBM of the one new type of light ICBM launched by that Party. In addition, after the twenty-fifth launch of an ICBM of that type, or after the last launch before deployment begins of ICBMs of that type, whichever occurs earlier, ICBMs of the one new type of light ICBM permitted to that Party shall not be different in any one or more of the following respects: the length, the largest diameter, the launch-weight, or the throw-weight, of the missile.

A Party which launches ICBMs of the one new type of light ICBM permitted pursuant to paragraph 9 of Article IV of the Treaty shall promptly notify the other Party of the date of the first launch and of the date of either the twenty-fifth or the last launch before deployment begins of ICBMs of that type, whichever occurs earlier.

Second Common Understanding. As used in the Second Agreed Statement to paragaph 9 of Article IV of the Treaty, the term 'different', referring to the length, the diameter, the launch-weight, and the throw-weight, of the missile, means a difference in excess of five per cent from the value established for each of the above parameters as of the twenty-fifth launch or as of the last launch before deployment begins, whichever occurs earlier. The values demonstrated in each of the above parameters during the last twelve of the twenty-five launches or during the last twelve launches before deployment begins, whichever twelve launches occur earlier, shall not vary by more than ten per cent from any other of the corresponding values demonstrated during those twelve launches.

Third Common Understanding. The limitations with respect to launch-weight and throw-weight, provided for in the First Agreed Statement and the First Common Understanding to paragraph 9 of Article IV of the Treaty, do not preclude the flight-testing or the deployment of ICBMs with fewer re-entry vehicles, or fewer penetration aids, or both, than the maximum number of re-entry vehicles and the maximum number of penetration aids with which ICBMs of that type have been flight-tested as of 1 May 1979, even if this results in a decrease in launch-weight or in throw-weight in excess of five per cent.

In addition to the aforementioned cases, those limitations do not preclude a decrease in launch-weight or throw-weight in excess of five per cent, in the case of the flight-testing or the deployment of ICBMs with a lesser quantity of propellant, including the propellant of a self-contained dispensing mechanism or other appropriate device, than the maximum quantity of propellant, including the

propellant of a self-contained dispensing mechanism or other appropriate device, with which ICBMs of that type have been flight-tested as of 1 May 1979, provided that such a ICBM is at the same time flight-tested or deployed with fewer re-entry vehicles, or fewer penetration aids, or both, than the maximum number of re-entry vehicles and the maximum number of penetration aids with which ICBMs of that type have been flight-tested as of 1 May 1979, and the decrease in launch-weight and throw-weight in such cases results only from the reduction in the numbers of re-entry vehicles, or penetration aids, or both, and the reduction in the quantity of propellant.

Fourth Common Understanding. The limitations with respect to launch-weight and throw-weight, provided for in the Second Agreed Statement and the Second Common Understanding to paragraph 9 of Article IV of the Treaty, do not preclude the flight-testing or the deployment of ICBMs of the one new type of light ICBM to each Party pursuant to paragraph 9 of Article IV of the Treaty with fewer re-entry vehicles, or fewer penetration aids, or both, than the maximum number of re-entry vehicles and the maximum number of penetration aids with which ICBMs of that type have been flight-tested, even if this results in a decrease in launch-weight or in throw-weight in excess of five per cent.

In addition to the aforementioned cases, those limitations do not preclude a decrease in launch-weight or in throw-weight in excess of five per cent, in the case of the flight-testing or the deployment of ICBMs of that type with a lesser quantity of propellant, including the propellant of a self-contained dispensing mechanism or other appropriate device, than the maximum quantity of propellant, including the propellant of a self-contained dispensing mechanism or other appropriate device, with which ICBMs of that type have been flight-tested, provided that such a ICBM is at the same time flight-tested or deployed with fewer re-entry vehicles, or fewer penetration aids, or both, than the maximum number of re-entry vehicles and the maximum number of penetration aids with which ICBMs of that type have been flight-tested, and the decrease in launch-weight and throw-weight in such cases results only from the reduction in the number of re-entry vehicles, or penetration aids, or both, and the reduction in the quantity of propellant.

10. Each Party undertakes not to flight-test or deploy ICBMs of a type flight-tested as of 1 May 1979 with a number of re-entry vehicles greater than the maximum number of re-entry vehicles with which an ICBM of that type has been flight-tested as of that date.

First Agreed Statement. The following types of ICBMs and SLBMs equipped with MIRVs have been flight-tested with the maximum number of re-entry vehicles set forth below:

For the United States of America

ICBMs of the Minuteman III type—seven re-entry vehicles;

SLBMs of the Poseidon C-3 type—fourteen re-entry vehicles;

SLBMs of the Trident C-4 type—seven re-entry vehicles;

For the Union of Soviet Socialist Republics

ICBMs of the RS-16 type—four re-entry vehicles;

ICBMs of the RS-18 type—six re-entry vehicles;

ICBMs of the RS-20 type—ten re-entry vehicles.

Common Understanding. Minuteman III ICBMs of the United States of America have been deployed with no more than three re-entry vehicles. During the term of the Treaty, the United States of America has no plans to and will not flight-test or deploy missiles of this type with more than three re-entry vehicles.

Second Agreed Statement. During the flight-testing of any ICBM, SLBM, or ASBM after 1 May 1979, the number of procedures for releasing or for dispensing may not exceed the maximum number of re-entry vehicles established for missiles of corresponding types as provided for in paragraphs 10, 11, 12 and 13 of Article IV of the Treaty. In this Second Agreed Statement 'procedures for releasing or for dispensing' are understood to mean manoeuvres of a missile associated with targeting and releasing or dispensing its re-entry vehicles to aim points, whether or not a re-entry vehicle is actually released or dispensed. Procedures for releasing anti-missile defence penetration aids will not be considered to be procedures for releasing or for dispensing a re-entry vehicle *so* long as the procedures for releasing anti-missile defence penetration aids differ from those for releasing or for dispensing re-entry vehicles.

Third Agreed Statement. Each Party undertakes:

(a) not to flight-test or deploy ICBMs equipped with multipe re-entry vehicles, of a type flight-tested as of 1 May 1979, with re-entry vehicles the weight of any of which is less than the weight of the lightest of those re-entry vehicles with which an ICBM of that type has been flight-tested as of that date;

(b) not to flight-test or deploy ICBMs equipped with a single re-entry vehicle and without an appropriate device for targeting a re-entry vehicle, of a type flight-tested as of 1 May 1979, with a re-entry vehicle the weight of which is less than the weight of the lightest re-entry vehicle on an ICBM of a type equipped with MIRVs and flight-tested by that Party as of 1 May 1979; and

(c) not to flight-test or deploy ICBMs equipped with a single re-entry vehicle and with an appropriate device for targeting a re-entry vehicle, of a type flight-tested as of 1 May 1979, with a re-entry vehicle the weight of which is less than fifty per cent of the throw-weight of that ICBM.

11. Each Party undertakes not to flight-test or deploy ICBMs of the one new type permitted pursuant to paragraph 9 of this Article with a number of re-entry vehicles greater than the maximum number of re-entry vehicles with which an ICBM of either Party has been flight-tested as of 1 May 1979, that is, ten.

First Agreed Statement. Each Party undertakes not to flight-test or deploy the one new type of ICBM permitted to each Party pursuant to paragraph 9 of Article IV of the Treaty with a number of re-entry vehicles greater than the maximum number of re-entry vehicles with which an ICBM of that type has been flight-tested as of the twenty-fifth launch or the last launch before deployment begins of ICBMs of that type, whichever occurs earlier.

Second Agreed Statement. During the flight-testing af any ICBM, SLBM, or ASBM after 1 May 1979 the number of procedures for releasing or for dispensing may not exceed the maximum number of re-entry vehicles established for missiles of corresponding types as provided for in paragraphs 10, 11, 12, and 13 of Article IV of the Treaty. In this Agreed Statement 'procedures for releasing or for dispensing' are understood to mean manoeuvres of a missile associated with targeting and releasing or dispensing its re-entry vehicles to aim points, whether or not a re-entry vehicle is actually released or dispensed. Procedures for releasing anti-missile defence penetration aids will not be considered to be procedures

for releasing or for dispensing a re-entry vehicle so long as the procedures for releasing anti-missile defence penetration aids differ from those for releasing or for dispensing re-entry vehicles.

12. Each Party undertakes not to flight-test or deploy SLBMs with a number of re-entry vehicles greater than the maximum number of re-entry vehicles with which an SLBM of either Party has been flight-tested as of 1 May 1979, that is, fourteen.

First Agreed Statement. The following types of ICBMs and SLBMs equipped with MIRVs have been flight-tested with the maximum number of re-entry vehicles set forth below:

For the United States of America

ICBMs of the Minuteman III type—seven re-entry vehicles;
SLBMs of the Poseidon C-3 type—fourteen re-entry vehicles;
SLBMs of the Trident C-4 type—seven re-entry vehicles;

For the Union of Soviet Socialist Republics

ICBMs of the RS-16 type—four re-entry vehicles;
ICBMs of the RS-18 type—six re-entry vehicles;
ICBMs of the RS-20 type—ten re-entry vehicles;
SLBMs of the RSM-50 type—seven re-entry vehicles.

Second Agreed Statement. During the flight-testing of any ICBM, SLBM, or ASBM after 1 May 1979, the number of procedures for releasing or for dispensing may not exceed the maximum number of re-entry vehicles established for missiles of corresponding types as provided for in paragraphs 10, 11, 12, and 13 of Article IV of the Treaty. In this Agreed Statement 'procedures for releasing or for dispensing' are understood to mean manoeuvres of a missile associated with targeting and releasing or dispensing its re-entry vehicles to aim points, whether or not a re-entry vehicle is actually released or dispensed. Procedures for releasing anti-missile defence penetration aids will not be considered to be procedures for releasing or for dispensing a re-entry vehicle so long as the procedures for releasing anti-missile defence penetration aids differ from those for releasing or for dispensing re-entry vehicles.

13. Each Party undertakes not to flight-test or deploy ASBMs with a number of re-entry vehicles greater than the maximum number of re-entry vehicles with which an ICBM of either Party has been flight-tested as of 1 May 1979, that is, ten.

Agreed Statement. During the flight-testing of any ICBM, SLBM, or ASBM after 1 May 1979, the number of procedures for releasing or for dispensing may not exceed the maximum number of re-entry vehicles established for missiles of corresponding types as provided for in paragraphs 10, 11, 12, and 13 of Article IV of the Treaty. In this Agreed Statement 'procedures for releasing or for dispensing' are understood to mean manoeuvres of a missile asociated with targeting and releasing or dispensing its re-entry vehicles to aim points, whether or not a re-entry vehicle is actually released or dispensed. Procedures for releasing anti-missile defence penetration aids will not be considered to be procedures for releasing or for dispensing a re-entry vehicle so long as the procedures for releasing anti-missile defence penetration aids differ from those for releasing or for dispensing re-entry vehicles.

14. Each Party undertakes not to deploy at any one time on heavy bombers equipped for cruise missiles capable of a range in excess of 600 kilometers a number of such cruise missiles which exceeds the product of 28 and the number of such heavy bombers.

First Agreed Statement. For the purposes of the limitation provided for in paragraph 14 of Article IV of the Treaty, there shall be considered to be deployed on each heavy bomber of a type equipped for cruise missile capable of a range in excess of 600 kilometers the maximum number of such missiles for which any bomber of that type is equipped for one operational mission.

Second Agreed Statement. During the term of the Treaty no bomber of the B-52 or B-1 types of the United States of America and no bomber of the Tupolev-95 or Myasishchev types of the Union of Soviet Socialist Republics will be equipped for more than twenty cruise missiles capable of a range in excess of 600 kilometers.

Article V

1. Within the aggregate numbers provided for in paragraphs 1 and 2 of Article III, each Party undertakes to limit launchers of ICBMs and SLBMs equipped with MIRVs, ASMBs equipped with MIRVs, and heavy bombers equipped for cruise missiles capable of a range in excess of 600 kilometers to an aggregate number not to exceed 1,320.

2. Within the aggregate number provided for in paragraph 1 of this Article, each Party undertakes to limit launchers of ICBMs and SLBMs equipped with MIRVs, and ASBMs equipped with MIRVs to an aggregate number not to exceed 1.200.

3. Within the aggregate number provided for in paragraph 2 of this Article each Party undertakes to limit launchers of ICBMs equipped with MIRVs to an aggregate number not to exceed 820.

4. For each bomber of a type equipped for ASBMs equipped with MIRVs, the aggregate numbers provided for in paragraphs 1 and 2 of this Article shall include the maximum number of ASBMs for which a bomber of that type is equipped for one operational mission.

Agreed Statement. If a bomber is equipped for ASBMs equipped with MIRVs, all bombers of that type shall be considered to be equipped for ASBMs equipped with MIRVs.

5. Within the aggregate numbers provided for in paragraphs 1.2 and 3 of this Article and subject to the provisions of this Treaty, each Party has the right to determine the composition of these aggregates.

Article VI

1. The limitations provided for in this Treaty shall apply to those arms which are:
   (a) operational;
   (b) in the final stage of construction;
   (c) in reserve, in storage, or mothballed;
   (d) undergoing overhaul, repair, modernization, or conversion.
2. Those arms in the final stage of construction are:
   (a) SLBM launchers on submarines whch have begun sea trials;
   (b) ASBMs after a bomber of a type equipped for such missiles has been brought out of the shop,

plant or other facility where its final assembly or conversion for the purpose of equipping it for such missiles has been performed;

(c) other strategic offensive arms which are finally assembled in a shop, plant, or other facility after they have been brought out of the shop, plant, or other facility where their final assembly has been performed.

3. ICBM and SLBM launchers of a type not subject to the limitation provided for in Article V, which undergo conversion into launchers of a type subject to that limitation, shall become subject to that limitation as follows:

(a) fixed ICBM launchers when work on their conversion reaches the stage which first definitely indicates that they are being so converted;

(b) SLBM launchers on a submarine when that submarine first goes to sea after their conversion has been performed.

Agreed Statement. If a bomber is equipped for ASBMs equipped with MIRVs, all bombers of that type shall be considered to be equipped for ASBMs equipped with MIRVs.

4. ASBMs on a bomber which undergoes conversion from a bomber of a type equipped for ASBMs which are not subject to the limitation provided for in Article V into a bomber of a type equipped for ASBMs which are subject to that limitation shall become subject to that limitation when the bomber is brought out of the shop, plant, or other facility where such conversion has been performed.

5. A heavy bomber of a type not subject to the limitation provided for in paragragh 1 of Article V shall become suject to that limitation when it is brought out of the shop, plant, or other facility where it has been converted into a heavy bomber of a type equipped for cruise missiles capable of a range in excess of 600 kilometers. A bomber of a type not subject to the limitation provided for in paragraph 1 or 2 of Article III shall become subject to that limitation and to the limitation provided for in paragraph 1 of Article V when it is brought out of the shop, plant, or other facility where it has been converted into a bomber of a type equipped for cruise missiles capable of a range in excess of 600 kilometers.

6. The arms subject to the limitations provided for in this Treaty shall continue to be subject to these limitations until they are dismantled, are destroyed, or otherwise cease to be subject to these limitations under procedures to be agreed upon.

Agreed Statement. The procedures referred to in paragraph 7 of Article IV of the Treaty shall include procedures determining the manner in which mobile ICBM launchers of a type not subject to the limitation provided for in Article V of the Treaty, which undergo conversion into launchers of a type subject to that limitation, shall become subject to that limitation, unless the Parties agree that mobile ICBM launchers shall not be deployed after the date on which the Protocol ceases to be in force.

Agreed Statement. The procedures for removal of strategic offensive arms from the aggregate numbers provided for in the Treaty, which are referred to in paragraph *6* of Article VI of the Treaty, and which are to be agreed upon in the Standing Consultative Commission, shall include:

(a) procedures for removal from the aggregate numbers, provided for in Article V of the Treaty. of ICBM and SLBM launchers which are being converted from launchers of a type subject to the limitation provided for in Article V of the Treaty, into launchers of a type not subject to that limitation;

(b) procedures for removal from the aggregate numbers, provided for in Articles III and V of the Treaty, of bombers which are being converted from bombers of a type subject to the limitations provided for in Article III of the Treaty or in Articles III and V of the Treaty into airplanes or bombers of a type not so subject.

Common Understanding. The procedures referred to in subparagraph **(b)** of the Agreed Statement to paragraph *6* of Article VI of the Treaty for removal of bombers from the aggregate numbers provided for in Articles III and V of the Treaty shall be based upon the existence of functionally related observable differences which indicate whether or not they can perform the mission of a heavy bomber, or whether or not they can perform the mission of a bomber equipped for cruise missiles capable of a range in excess of 600 kilometers.

7. In accordance with the provisions of Article XVII, the Parties will agree in the Standing Consultative Commission upon procedures to implement the provisions of this Article.

Article VII

1. The limitations provided for in Article III shall not apply to ICBM and SLBM test and training launchers or to space vehicle launchers for exploration and use of outer space. ICBM and SLBM test and training launchers are ICBM and SLBM launchers used only for testing or training.

Common Understanding. The term 'testing', as used in Article VII of the Treaty, includes research and development.

2. The Parties agree that:

(a) there shall be no significant increase in the number of ICBM and SLBM test and training launchers or in the number of such launchers of heavy ICBMs;

(b) construction or conversion of ICBM launchers at test ranges shall be undertaken only for purposes of testing and training;

(c) there shall be no conversion of ICBM test and training launchers or of space vehicle launchers into ICBM launchers subject to the limitations provided for in Article **III.**

First Agreed Statement: The term 'significant increase', as used in subparagraph 2(a) of Article VII of the Treaty, means an increase of fifteen per cent or more. Any new ICBM test and training launchers which replace ICBM test and training launchers will be located only at test ranges.

Second Agreed Statement. Current test ranges where ICBMs are tested and located; for the United States of America, near Santa Maria, California, and at Cape Canaveral, Florida; and for the Union of Soviet Socialist Republics, in the areas of Tyura-Tam and Plesetskaya. In the future, each Party shall provide notification in the Standing Consultative Commission of the location of any other test range used by that Party to test ICBMs.

First Common Understanding. At test ranges where ICBMs are tested, other arms, including those not limited by the Treaty, may also be tested.

Second Common Understanding. Of the eighteen launchers of fractional orbital missiles at the test range where ICBMs are tested in the area of Tyura-Tam, twelve launchers shall be dismantled or

destroyed and six launchers may be converted to launchers for testing missiles undergoing modernization.

Dismantling or destruction of the twelve launchers shall begin upon entry into force of the Treaty and shall be completed within eight months, under procedures for dismantling or destruction of these launchers to be agreed upon in the Standing Consultative Commission. These twelve launchers shall not be replaced.

Conversion of the six launchers may be carried out after entry into force of the Treaty. After entry into force of the Treaty, fractional orbital missiles shall be removed and shall be destroyed pursuant to the provisions of subparagraph 1(c) of Article IX and of Article XI of the Treaty and shall not be replaced by other missiles, except in the case of conversion of these six launchers for testing missiles undergoing modernization. After removal of the fractional orbital missiles, and prior to such conversions, any activities associated with these launchers shall be limited to normal maintenance requirements for launchers in which missiles are not deployed. These six launchers shall be subject to the provisions of Article VII of the Treaty and, if converted, to the provisions of the Fifth Common Understanding to paragraph 5 of Article II of the Treaty.

Article VIII

1. Each Party undertakes not to flight-test cruise missiles capable of a range in excess of 600 kilometers or ASBMs from aircraft other than bombers or to convert such aircraft into aircraft equipped for such missiles.

Agreed Statement. For purposes of testing only, each Party has the right, through initial construction or, as an exception to the provisions of paragraph 1 of Article VIII of the Treaty, by conversion, to equip for cruise missiles capable of a range in excess of 600 kilometers or for ASBMs no more than sixteen airplanes, including airplanes which are prototypes of bombers equipped for such missiles. Each Party also has the right, as an exception to the provisions of paragraph 1 of Article VIII of the Treaty, to flight-test from such airplanes cruise missiles capable of a range in excess of 600 kilometers and, after the date on which the Protocol ceases to be in force, to flight-test ASBMs from such airplanes as well, unless the Parties agree that they will not flight-test ASBMs after that date. The limitations provided for in Article III of the Treaty shall not apply to such airplanes.

The aforementioned airplanes may include only:

(a) airplanes other than bombers which, as an exception to the provisions of paragraph 1 of Article VIII of the Treaty, have been converted into airplanes equipped for cruise missiles capable of a range in excess of 600 kilometers or for ASBMs;

(b) airplanes considered to be heavy bombers pursuant to subparagraph 3(c) or 3(d) of Article II of the Treaty; and

(c) airplanes other than heavy bombers which, prior to 7 March 1979, were used for testing cruise missiles capable of a range in excess of 600 kilometers.

The airplanes referred to in subparagraphs (a) and (b) of this Agreed Statement shall be distinguishable on the basis of functionally related observable differences from airplanes which otherwise would be of the same type but cannot perform the mission of a bomber equipped for cruise missiles capable of a range in excess of 600 kilometers or for ASMBs.

The airplanes referred to in subparagraph (c) of the Agreed Statement shall not be used for testing cruise missiles capable of a range in excess of 600 kilometers after the expiration of a six-month period from the date of entry into force of the Treaty, unless by the expiration of that period they are distinguishable on the basis of functionally related observable differences from airplanes which otherwise would be of the same type but cannot perform the mission of a bomber equipped for cruise missiles capable of a range in excess of 600 kilometers.

First Common Understanding. The term 'testing', as used in the Agreed Statement to paragraph 1 of Article VIII of the Treaty, includes research and development.

Second Common Understanding. The Parties shall notify each other in the Standing Consultative Commission of the number of airplanes, according to type, used for testing pursuant to the Agreed Statement to paragraph 1 of Article VIII of the Treaty. Such notification shall be provided at the first regular session of the Standing Consultative Commission held after an airplane has been used for such testing.

Third Common Understanding. None of the sixteen airplanes referred to in the Agreed Statement to paragraph 1 of Article VIII of the Treaty may be replaced, except in the event of the involuntary destruction of any such airplane or in the case of the dismantling or destruction of any such airplane. The procedures for such replacement and for removal of any such airplane from that number, in case of its conversion, shall be agreed upon in the Standing Consultative Commission.

2. Each Party undertakes not to convert aircraft other than bombers into aircraft which can carry out the mission of a heavy bomber as referred to in subparagraph 3(b) of Article II.

Article IX

1. Each Party undertakes not to develop, test, or deploy:

(a) ballistic missiles capable of a range in excess of 600 kilometers for installation on waterborne vehicles other than submarines, or launchers of such missiles;

(b) fixed ballistic or cruise missile launchers for emplacement on the ocean floor, on the seabed, or on the beds of internal waters and inland waters, or in the subsoil thereof, or mobile launchers of such missiles, which move only in contact with the ocean floor, the seabed, or the beds of internal waters and inland waters, or missiles for such launchers;

(c) Systems for placing into Earth orbit nuclear weapons or any other kind of weapons of mass destruction, including fractional orbital missiles;

(d) mobile launchers of heavy ICBMs;

(e) SLBMs which have a launch-weight greater or a throw-weight greater than that of the heaviest, in terms of either launch-weight or throw-weight, respectively, of the light ICBMs deployed by either Party as of the date of signature of this Treaty, or launchers of such SLBMs; or

(f) ASBMs which have a launch-weight greater or a throw-weight greater than that of the heaviest,

in terms of either launch-weight or throw-weight, respectively, of the light ICBMs deployed by either Party as of the date of signature of this Treaty.

Common Understanding to Subparagraph (a). The obligations provided for in subparagraph 1(a) of Article IX of the Treaty do not affect current practices for transporting ballistic missiles.

Agreed Statement to Subparagraph (b). The obligations provided for in subparagraph 1(b) of Article IX of the Treaty shall apply to all areas of the ocean floor and the seabed, including the seabed zone referred to in Articles I and II of the 1971 Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Seabed and the Ocean Floor and in the Subsoil Thereof.

Common Understanding to Subparagraph (c). The provisions of subparagraph 1(c) of Article IX of the Treaty do not require the dismantling or destruction of any existing launchers of either Party.

First Agreed Statement to Subparagraphs (e) and (f). The launch-weight of an SLBM or of an ASBM is the weight of the fully loaded missile itself at the time of launch.

Second Agreed Statement to Subparagraphs (e) and (f). The throw-weight of an SLBM or of an ASBM is the sum weight of:

(a) its re-entry vehicle or re-entry vehicles;

(b) any self-contained dispensing mechanism or other appropriate devices for targeting one re-entry vehicle, or for releasing or for dispensing and targeting two or more re-entry vehicles; and

(c) its penetration aids, including devices for their release.

Common Understanding to Subparagraphs (e) and (f). The term 'other appropriate devices', as used in the definition of the throw-weight of an SLBM or of an ASBM in the Second Agreed Statement to Subparagraphs 1(e) and 1(f) of Article IX of the Treaty, means any devices for dispensing and targeting two or more re-entry vehicles: and any devices for releasing two or more re-entry vehicles or for targeting one re-entry vehicle, which cannot provide their re-entry vehicles or re-entry vehicle with additional velocity of more than 1,000 metres per second.

2. Each Party undertakes not to flight-test from aircraft cruise missiles capable of a range in excess of 600 kilometers which are equipped with multiple independently targetable warheads and not to deploy such cruise missiles on aircraft.

Agreed Statement. Warheads of a cruise missile are independently targetable if manoeuvring or targeting of the warheads to separate aim points along ballistic trajectories or any other flight paths, which are unrelated to each other, is accomplished during a flight of a cruise missile.

Article X

Subject to the provisions of this Treaty, modernization and replacement of strategic offensive arms may be carried out.

Article XI

1. Strategic offensive arms which would be in excess of the aggregate numbers provided for in this Treaty as well as strategic offensive arms prohibited by this Treaty shall be dismantled or destroyed under procedures to be agreed upon in the Standing Consultative Commission.
2. Dismantling or destruction of strategic offensive arms which would be in excess of the aggregate number provided for in paragraph 1 of Article III shall begin on the date of entry into force of this Treaty and shall be completed within the following periods from that date: four months for ICBM launchers; six months for SLBM launchers; and three months for heavy bombers.
3. Dismantling or destruction of strategic offensive arms which would be in excess of the aggregate number provided for in paragraph 2 of Article III shall be initiated no later than 1 January 1981, shall be carried out throughout the ensuing twelve-month period, and shall be completed no later than 31 December 1981.
4. Dismantling or destruction of strategic offensive arms prohibited by this Treaty shall be completed within the shortest possible agreed period of time, but no later than six months after the entry into force of this Treaty.

Article XII

In order to ensure the viability and effectiveness of this Treaty, each Party undertakes not to circumvent the provisions of this Treaty, through any other state or states, or in any other manner.

Article XIII

Each Party undertakes not to assume any international obligations which would conflict with this Treaty.

Article XIV

The Parties undertake to begin, promptly after the entry into force of this Treaty, active negotiations with the objective of achieving, as soon as possible, agreement on further measures for the limitation and reduction of strategic arms. It is also the objective of the Parties to conclude well in advance of 1985 an agreement limiting strategic offensive arms to replace this Treaty upon its expiration.

Article XV

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in an manner consistent with generally recognized principles of international law.
2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating **in** accordance with paragraph 1 of this Article.
3. Each Party undertakes not to use deliberate concealment measures which impede verification by national technical means of compliance with the provisions of this Treaty. This obligation shall not require changes in current construction, assembly, conversion, or overhaul practices.
First Agreed Statement. Deliberate concealment measures, as referred to in paragraph 3 of Article XV of the Treaty, are measures carried out deliberately to hinder or deliberately to impede verification by national technical means of compliance with the provisions of the Treaty.
Second Agreed Statement. The obligation not to use deliberate concealment measures, provided for in paragraph 3 of Article XV of the Treaty, does not preclude the testing of anti-missile defence penetration aids.
First Common understanding. The provisions of paragraph 3 of Article XV of the Treaty and the First Agreed Statement thereto apply to all provisions of the Treaty, including provisions associated with testing. In this connection, the obligation not to use deliberate concealment measures includes the obligation not to use deliberate concealment measures associated with testing, including those measures aimed at concealing the association between ICBMs and launchers during testing.
Second Common Understanding. Each Party is free to use various methods of transmitting telemetric information during testing, including its encryption, except that, in accordance with the provisions of paragraph 3 of Article XV of the Treaty, neither Party shall engage in deliberate denial of telemetric information, such as through the use of telemetry encryption, whenever such denial impedes verification of compliance with the provisions of the Treaty.
Third Common understanding. In addition to the obligations provided for in paragraph 3 of Article XV of the Treaty, no shelters which impede verification by national technical means of compliance with the provisions of the Treaty shall be used over ICBM silo launchers.
First Common Understanding. ICBM launchers to which the obligations provided for in Article XVI of the Treaty apply, include, among others, those ICBM launchers for which advance notification is required pursuant to the provisions of the Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War Between the United States of America and the Union of Soviet Socialist Republics, signed 30 September 1971, and the Agreement Between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on the Prevention of Incidents On and Over the High Seas, signed 25 May 1972. Nothing in Article XVI of the Treaty is intended to inhibit advance notification, on a voluntary basis, of any ICBM launches not subject to its provisions, the advance notification of which would enhance confidence between the Parties.
Second Common Understanding. A multiple ICBM launch conducted by a Party, as distinct from single ICBM launches referred to in Article XVI of the Treaty, is a launch which would result in two or more of its ICBMs being in flight at the same time.
Third Common Understanding. The test ranges referred to in Article XVI of the Treaty are those covered by the Second Agreed Statement to paragraph 2 of Article VII of the Treaty.

Article XVI

1. Each Party undertakes, before conducting each planned ICBM launch, to notify the other Party well in advance on a case-by-case basis that such a launch will occur, except for single ICBM launches from test ranges or from ICBM launcher deployment areas, which are not planned to extend beyond its national territory.
2. The Parties shall agree in the Standing Consultative Commission upon procedures to implement the provisions of this Article.

Article XVII

1. To promote the objectives and implementation of the provisions of this Treaty, the Parties shall use the Standing Consultative Commission established by the Memorandum of Understanding Between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics Regarding the Establishment of a Standing Consultative Commission of 21 December 1972.
2. Within the framework of the Standing Consultative Commission, with respect to this Treaty, the Parties will:

(a) consider questions concerning compliance with the obligations assumed and related situations which may be considered ambiguous;

(b) provide on a voluntary basis such information as either Party considers necessary to assure confidence in compliance with the obligations assumed;

(c) consider questions involving unintended interference with national technical means of verification, and questions involving unintended impeding of verification by national technical means of compliance with the provisions of this Treaty;

(d) consider possible changes in the strategic situation which have a bearing on the provisions of this Treaty;

(e) agree upon procedures for replacement, conversion, and dismantling or destruction, of strategic offensive arms in cases provided for in the provisions of this Treaty and upon procedures for removal of such arms from the aggregate numbers when they otherwise cease to be subject to the limitations provided for in this Treaty and at regular sessions of the Standing Consultative Commission, notify each other in accordance with the aforementioned procedures, at least twice annually, of actions completed and those in process;

(f) consider, as appropriate, possible proposals for further increasing the viability of this Treaty, including proposals for amendments in accordance with the provisions of this Treaty;

(g) consider, as appropriate, proposals for further measures limiting strategic offensive arms.

3. In the Standing Consultative Commission the Parties shall maintain by category the agreed data base on the numbers of strategic offensive arms established by the Memorandum of Understanding Between the United States of America and the Union of Soviet Socialist Republics Regarding the Establishment of a Data Base on the Numbers of Strategic Offensive Arms of 18 June 1979.

Agreed Statement. In order to maintain the agreed data base on the numbers of strategic offensive arms subject to the limitations provided for in the Treaty in accordance with paragraph 3 of Article XVII of the Treaty, at each regular session of the Standing Consultative Commission the Parties will notify each other of and consider changes in those numbers in the following categories: launchers of ICBMs; fixed launchers of ICBMs; launchers of ICBMs equipped with MIRVs; launchers of SLBMs; launchers of SLBMs equipped with MIRVs; heavy bombers equipped for cruise missiles capable of a range in excess of 600 kilometers; heavy bombers equipped only for ASBMs; ASBMs; and ASBMs equipped with MIRVs.

Article XVIII

Each Party may propose amendments to this Treaty. Agreed amendments shall enter into force in accordance with the procedures governing the entry into force of this Treaty.

Article XIX

1. This Treaty shall be subject to ratification in accordance with the constitutional procedures of each Party. This Treaty shall enter into force on the day of exchange of instruments of ratification and shall remain in force through 31 December 1985, unless replaced earlier by an agreement further limiting strategic offensive arms.
2. This Treaty shall be registered pursuant to Article 102 of the Charter of the United Nations.
3. Each Party shall, in exercising its national sovereignity, have the right to withdraw from this Treaty if it decides that extraordinary events related to the subject matter of this Treaty have jeopardized its supreme interests. It shall give notice of its decision to the other Party six months prior to withdrawal from the Treaty. Such notice shall include a statement of the extraordinary events the notifying Party regards as having jeopardized its supreme interests.

NOTE: *The text of the SALT II Treaty and Protocol, as signed in Vienna, is accompanied by a set of Agreed Statements and Common Understandings. signed by Presidents Carter and Brezhnev, prefaced as follows:*

"In connection with the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Strategic Offensive Arms. the Parties have agreed on the following Agreed Statements and Common Understandings undertaken on behalf of the Government of the United States of America and the Government of the Union of Soviet Socialist Republics."

Protocol to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Strategic Offensive Arms (SALT 2)

18 June 1979

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Having agreed on limitations on strategic offensive arms in the Treaty,

Have agreed on additional limitations for the period during which this Protocol remains in force, as follows:

Article I

Each Party undertakes not to deploy ICBM launchers or to flight-test ICBMs from such launchers.

Article II

1. Each Party undertakes not to deploy cruise missiles capable of a range in excess of 600 kilometers on sea-based launchers or on land-based launchers.
2. Each Party undertakes not to flight-test cruise missiles capable of a range in excess of 600 kilometers which are equipped with multiple independently targetable warheads from sea-based launchers or from land-based launchers.

Agreed Statement. Warheads of a cruise missile are independently targetable if manoeuvring or targeting of the warheads to separate aim points along ballistic trajectories or any other flight paths, which are unrelated to each other, is accomplished during a flight of a cruise missile.

3. For the purpose of this Protocol, cruise missiles are unmanned, self-propelled, guided, weapon-delivery vehicles which sustain flight through the use of aerodynamic lift over most of their flight path and which are flight-tested from or deployed on sea-based or land-based launchers, that is, sea-launched cruise missiles and ground-launched cruise missiles, respectively.

First Agreed Statement. If a cruise missile is capable of a range in excess of 600 kilometers, all cruise missiles of that type shall be considered to be cruise missiles capable of a range in excess of 600 kilometers.

First Common Understanding. If a cruise missile has been flight-tested to a range in excess of 600 kilometers, it shall be considered to be a cruise missile capable of a range in excess of 600 kilometers.

Second Common Understanding. Cruise missiles not capable of a range in excess of 600 kilometers shall not be considered to be of a type capable of a range in excess of 600 kilometers if they are distinguishable on the basis of externally observable design features from cruise missiles of types capable of a range in excess of 600 kilometers.

Second Agreed Statement. The range of which a cruise missile is capable is the maximum distance which can be covered by the missile in its standard design mode flying until fuel exhaustion, determined by projecting its flight path onto the Earth's sphere from the point of launch to the point of impact.

Third Agreed Statement. If an unmanned, self-propelled, guided vehicle which sustains flight through the use of aerodynamic lift over most of its flight path has been flight-tested or deployed for weapon-delivery, all vehicles of that type shall be considered to be weapon-delivery vehicles.

Third Common Understanding. Unmanned, self-propelled, guided vehicles which sustain flight through the use of aerodynamic lift over most of their flight path and are not weapon-delivery vehicles, that is, unarmed, pilotless, guided vehicles, shall not be considered to be cruise missiles if such vehicles are distinguishable from cruise missiles on the basis of externally observable design features.

Fourth Common Understanding. Neither Party shall convert unarmed, pilotless, guided vehicles into cruise missiles capable of a range in excess of 600 kilometers, nor shall either Party convert cruise missiles capable of a range in excess of 600 kilometers into unarmed, pilotless, guided vehicles.

Fifth Common Understanding. Neither Party has plans during the term of the Protocol to flight-test from or deploy on sea-based or land-based launchers unarmed, pilotless, guided vehicles which are capable of a range in excess of 600 kilometers. In the future, should a Party have such plans, that Party will provide notification thereof to the other Party well in advance of such flight-testing or deployment. This Common Understanding does not apply to target drones.

Article III

Each Party undertakes not to flight-test or deploy ASBMs.

Article IV

This Protocol shall be considered an integral part of the Treaty. It shall enter into force on the day of the entry into force of the Treaty and shall remain in force through 31 December 1981, unless replaced earlier by an agreement on further measures limiting strategic offensive arms.

Agreement Between the United States of America and the Union of Soviet Socialist Republics on the Establishment of Nuclear Risk Reduction Centers

15 September 1987

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Affirming their desire to reduce and ultimately eliminate the risk of outbreak of nuclear war, in particular, as a result of misinterpretation, miscalculation, or accident,

Believing that a nuclear war cannot be won and must never be fought,

Believing that agreement on measures for reducing the risk of outbreak of nuclear war serves the interests of strengthening international peace and security,

Reaffirming their obligations under the Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War between the United States of America and the Union of Soviet Socialist Republics of September 30, 1971, and the Agreement between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on the Prevention of Incidents on and over the High Seas of May 25, 1972,

Have agreed as follows:

Article 1

Each Party shall establish, in its capital, a national Nuclear Risk Reduction Center that shall operate on behalf of and under the control of its respective Government.

Article 2

The Parties shall use the Nuclear Risk Reduction Centers to transmit notifications identified in Protocol I which constitutes an integral part of this Agreement.

In the future, the list of notifications transmitted through the Centers may be altered by agreement between the Parties, as relevant new agreements are reached.

Article 3

The Parties shall establish a special facsimile communications link between their national Nuclear Risk Reduction Centers in accordance with Protocol II which constitutes an integral part of this Agreement.

Article 4

The Parties shall staff their national Nuclear Risk Reduction Centers as they deem appropriate, so as to ensure their normal functioning.

Article 5

The Parties shall hold regular meetings between representatives of the Nuclear Risk Reduction Centers at least once each year to consider matters related to the functioning of such Centers.

Article 6

This Agreement shall not affect the obligations of either Party under other agreements.

Article 7

This Agreement shall enter into force on the date of its signature.
The duration of this Agreement shall not be limited.
This Agreement may be terminated by either Party upon 12 months written notice to the other Party.

DONE at Washington on September 15, 1987, in two copies, each in the English and Russian languages, both texts being equally authentic.

FOR THE UNITED STATES OF AMERICA	FOR THE UNION OF SOVIET SOCIALIST REPUBLICS
George P Shultz	Eduard A Shevardnadze

Protocol 1 to the Agreement Between the United States of America and the Union of Soviet Socialist Republics on the Establishment of Nuclear Risk Reduction Centers

15 September 1987

Pursuant to the provisions and in implementation of the Agreement between the United States of America and the Union of Soviet Socialist Republics on the Establishment of Nuclear Risk Reduction Centers, the Parties have agreed as follows:

Article 1

The Parties shall transmit the following types of notifications through the Nuclear Risk Reduction Centers:

(a) notifications of ballistic missile launches under Article 4 of the Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War between the United States of America and the Union of Soviet Socialist Republics of September 30, 1971;

(b) notifications of ballistic missile launches under paragraph 1 of Article VI of the Agreement between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on the Prevention of Incidents on and over the High Seas of May 25, 1972.

Article 2

The scope and format of the information to be transmitted through the Nuclear Risk Reduction Centers shall be agreed upon.

Article 3

Each Party also may, at its own discretion as a display of good will and with a view to building confidence, transmit through the Nuclear Risk Reduction Centers communications other than those provided for under Article 1 of this Protocol.

Article 4

Unless the Parties agree otherwise, all communications transmitted through and communications procedures of the Nuclear Risk Reduction Center's communication link will be confidential.

Article 5

This Protocol shall enter into force on the date of its signature and shall remain in force as long as the Agreement between the United States of America and the Union of Soviet Socialist Republics on the Establishment of Nuclear Risk Reduction Centers of September 15, 1987, remains in force.

DONE at Washington on September 15, 1987, in two copies, each in the English and Russian languages, both texts being equally authentic.

FOR THE UNITED STATES OF AMERICA
George P Shultz

FOR THE UNION OF SOVIET SOCIALIST REPUBLICS
Eduard A Shevardnadze

Protocol 2 to the Agreement Between the United States of America and the Union of Soviet Socialist Republics on the Establishment of Nuclear Risk Reduction Centers

15 September 1987

Pursuant to the provisions and in implementation of the Agreement Between the United States of America and the Union of Soviet Socialist Republics on the Establishment of Nuclear Risk Reduction Centers, the Parties have agreed as follows:

Article 1

To establish and maintain for the purpose of providing direct facsimile communications between their national Nuclear Risk Reduction Centers, established in accordance with Article 1 of this Agreement, hereinafter referred to as the national Centers, an INTELSAT satellite circuit and a STATSIONAR satellite circuit, each with a secure orderwire communications capability for operational monitoring. In this regard:

(a) There shall be terminals equipped for communication between the national Centers;

(b) Each Party shall provide communications circuits capable of simultaneously transmitting and receiving 4,800 bits per second;

(c) Communication shall begin with test operation of the INTELSAT satellite circuit, as soon as purchase, delivery and installation of the necessary equipment by the Parties are completed. Thereafter, taking into account the results of test operations, the Parties shall agree on the transition to a fully operational status;

(d) To the extent practicable, test operation of the STATSIONAR satellite circuit shall begin simultaneously with test operation of the INTELSAT satellite circuit. Taking into account the results of test operations, the Parties shall agree on the transition to a fully operational status.

Article 2

To employ agreed-upon information security devices to assure secure transmission of facsimile messages. In this regard:

(a) The information security devices shall consist of microprocessors that will combine the digital message output with buffered random data read from standard 5¼ inch floppy disks;

(b) Each Party shall provide, through its Embassy, necessary keying material to the other.

Article 3

To establish and maintain at each operating end of the two circuits, facsimile terminals of the same make and model. In this regard:

(a) Each party shall be responsible for the purchase, installation, operation and maintenance of its own terminals, the related information security devices, and local transmission circuits appropriate to the implementation of this Protocol;

(b) A Group III facsimile unit which meets CCITT Recommendations T.4 and T.30 and operates at 4,800 bits per second shall be used;

(c) Direct facsimile messages from the USSR national Center to the US national Center shall be transmitted and received in the Russian language, and from the US national Center to the USSR national Center in the English language;

(d) Transmission and operating procedures shall be in conformity with procedures employed on the Direct Communications Link and adapted as necessary for the purpose of communications between the national Centers.

Article 4

To establish and maintain a secure orderwire communications capability necessary to coordinate facsimile operation. In this regard:

(a) The orderwire terminals used with the information security devices described in paragraph (a) of Article 2 shall incorporate standard USSR Cyrillic and United States Latin keyboards and cathode ray tube displays to permit the exchange of messages between operators. The specific layout of the Cyrillic keyboard shall be as specified by the Soviet side;

(b) To coordinate the work of operators, the orderwire shall be configured *so* as to permit, prior to the transmission and reception of messages, the exchange of all information pertinent to the coordination of such messages;

(c) Orderwire messages concerning transmissions shall be encoded using the same information security devices specified in paragraph (a) of Article 2;

(d) The orderwire shall use the same modem and communications link as used for facsimile message transmission;

(e) A printer shall be included to provide a record copy of all information exchanged on the orderwire.

Article 5

To use the same type of equipment and the same maintenance procedures as currently in use for the Direct Communications Link for the establishment of direct facsimile communications between the national Centers. The equipment, security devices, and spare parts necessary for telecommunications links and the orderwire shall be provided by the United States side to the Soviet side in return for payment of costs thereof by the Soviet side.

Article 6

To ensure the exchange of information necessary for the operation and maintenance of the telecommunication system and equipment configuration.

Article 7

To take all possible measures to assure the continuous, secure and reliable operation of the equipment and communications link, including the orderwire, for which each Party is responsible in accordance with this Protocol.

Article 8

To determine, by mutual agreement between technical experts of the Parties, the distribution and calculation of expenses for putting into operation the communication link, its maintenance and further development.

Article 9

To convene meetings of technical experts of the Parties in order to consider initially questions pertaining to the practical implementation of the activities provided for in this Protocol and, thereafter, by mutual agreement and as necessary for the purpose of improving telecommunications and information technology in order to achieve the mutually agreed functions of the national Centers.

Article ·10

This Protocol shall enter into force on the date of its signature and shall remain in force as long as the agreement between the United States of America and the Union of Soviet Socialist Repbulics on the Establishment of Nuclear Risk Reduction Centers of September 15, 1987, remains in force.

DONE at Washington on September 15, 1987, in two copies, each in the English and Russian languages, both texts being equally authentic.

FOR THE UNITED STATES OF AMERICA	FOR THE UNION OF SOVIET SOCIALIST REPUBLICS
George P Shultz	Eduard A Shevardnadze

Missile Technology Control Regime (MTCR)

7 January 1993

The first guidelines on the Missile Technology Control Regime were published by the seven original signatories on 16 April 1987, but these were updated and republished on 7 January 1993. The signatory governments, who had increased to 22 at January 1993, formulated joint guidelines and identical annexes and these are reproduced below as published by the United Kingdom Government. However, the MTCR is not a treaty, and the actual controls remain the national responsibility of each participating country.

Missile Technology Control Regime

The Government of the United Kingdom has, after careful consideration and subject to its international treaty obligations, decided that, when considering the transfer of equipment and technology related to missiles, it will act in accordance with the attached Guidelines beginning on 7 January 1993. These guidelines replace those adopted on 15 April 1987.

Guidelines for Sensitive Missile-Relevant Transfers

1. The purpose of these Guidelines is to limit the risks of proliferation of weapons of mass destruction (ie nuclear, chemical and biological weapons), by controlling transfers that could make a contribution to delivery systems (other than manned aircraft) for such weapons. The Guidelines are not designed to impede national space programmes or international co-operation in such programmes as long as such programme could not contribute to delivery systems for weapons of mass destruction. These Guidelines, including the attached Annex, form the basis for controlling transfers to any destination beyond the Government's jurisdiction or control of all delivery systems (other than manned aircraft) capable of delivering weapons of mass destruction, and of equipment and technology relevent to missiles whose peformance in terms of payload and range exceeds stated parameters. Restraint will be exercised in the consideration of all transfers of items contained within the Annex and all such transfers will be considered on a case-by-case basis. The Government will implement the Guidelines in accordance with national legislation.

2. The Annex consists of two categories of items, which term includes equipment and technology. Category I items, all of which are in Annex Item 1 and 2, are those items of greatest sensitivity. If a Category I item is included in a system, that system will also be considered as Category I, except when the incorporated item cannot be separated, removed or duplicated. Particular restraint will be exercised in the consideration of Category I transfers regardless of their purpose, and there will be a strong presumption to deny such transfers. Particular restraint will also be exercised in the consideration of transfers of any items in the Annex, or of any missiles (whether or not in the Annex), if the Government judges, on the basis of all available, persuasive information, evaluated according to factors including those in paragraph 3, that they are intended to be used for the delivery of weapons of mass destruction, and there will be strong presumption to deny such transfers. Until further notice, the transfers of Category I production facilities will not be authorised. The transfer of other Category I items will be authorised only on rare occasions and where the Government (A) obtains binding government-to-government undertakings embodying the assurances from the recipient government called for in paragraph 5 of these Guidelines and (B) assumes responsibility for taking all steps necessary to ensure that the item is put only to its stated end-use. It is understood that the decision to transfer remains the sole and sovereign judgement of the Government.

3. In the evaluation of transfer applications for Annex items, the following factors will be taken into account:

(a) Concerns about the proliferation of weapons of mass destruction;

(b) The capabilities and objectives of the missile and space programmes of the recipient state:

(c) The significance of the transfer in terms of the potential development of delivery systems (other than manned aircraft) for weapons of mass destruction;

(d) The assessment of the end-use of the transfers, including the relevant assurance of the recipient states referred to in subparagraphs 5.A and 5.B below:

(e) The applicability of relevant multilateral agreements.

4. The transfer of design and production technology directly associated with any items in the Annex will be subject to as great a degree of scrutiny and control as will the equipment itself, to the extent permitted by national legislation.

5. Where the transfer could contribute to delivery system for weapons of mass destruction, the Government will authorise transfers of items in the Annex only in receipt of appropriate assurances from the government of the recipient state that:

(a) The item will be used only for the purpose stated and that such use will not be modified nor the items modified or replicated without the prior consent of the Government;

(b) Neither the items nor replicas nor derivatives thereof will be retransferred without the consent of the Government.

6. In furtherance of the effective operation of the Guidelines, the Government will, as necessary and appropriate, exchange relevant information with other governments applying the same Guidelines.

7. The adherence of all States to these Guidelines in the interest of international peace and security would be welcome.

Missile Technology Control Regime - Equipment and Technology Annex

March 1993

1. Introduction

(a) This Annex consists of two categories of items, which term includes equipment and "technology". Category I items, all of which are in Annex items 1 and 2, are those items of greatest sensitivity. If a Category I item is included in a system, that system will also be considered as Category I, except when the incorporated item cannot be separated, removed or duplicated. Category II items are those items in the Annex not designated Category I.

(b) The transfer of "technology" directly associated with any items in the Annex will be subject to as great a degree of scrutiny and control as will the equipment itself, to the extent permitted by national legislation. The approval of any Annex item for export also authorizes the export to the same end user of the minimum technology required for the installation, operation, maintenance, and repair of the item.

(c) In reviewing the proposed applications for transfers of complete rocket and unmanned air vehicle systems decribed in items 1 and 19, and of equipment or technology which is listed in the Technical Annex, for potential use in such systems, the Government will take account of the ability to trade off range and payload.

2. Definitions

For the purpose of this Annex, the following definitions apply:

(a) "Development" is related to all phases prior to "production" such as:
- -design
- -design research
- -design analysis
- -design concepts
- -assembly and testing of prototypes
- - pilot production schemes
- -design data
- - process of transforming design data into a product
- - configuration design
- - integration design
- - layouts

(b) A "microcircuit" is defined as a device in which a number of passive and/or active elements are considered as indivisibly associated on or within a continuous structure to perform the function of a circuit.

(c) "Production" means all production phases such as:
- - production engineering
- - manufacture
- - integration
- -assembly (mounting)
- - inspection
- -testing
- -quality assurance

(d) "Production equipment" means tooling, templates, jigs, mandrels, moulds, dies, fixtures, alignment mechanisms, test equipment, other machinery and components therefor, limited to those specially designed or modified for "development" or for one or more phases of "production".

(e) "Production facilities" means equipment and specially designed software therefor integrated into installations for "development" or for one or more phases of "production".

(f) "Radiation Hardened" means that the component or equipment is designed or rated to withstand radiation levels which meet or exceed a total irradiation dose of 5×10^5 rads (Si).

(g) "Technology" means specific information which is required for the 'development", "production" or "use" of a product. The information may take the form of "technical data" or "technical assistance".

(1) "Technical assistance" may take forms such as:
- - instruction
- -skills
- -training
- -working knowledge
- -consulting services

(2) "Technical data" may take forms such as:
- - blueprints
- - plans
- -diagrams
- - models
- -formulae
- - engineering designs and specifications
- - manuals and instructions written or recorded on other media or device such as:
  - -disk
  - -tape
  - - read-onlv memories

Note:
This definition of technology does not include technology "in the public domain" nor "basic scientific research".

(i) "In the public domain" as it applies to this Annex means technology which has been made available without restrictions upon its further dissemination. (Copyright restrictions do not remove technology from being "in the public domain".)

(ii) "Basic scientific research" means experimental or theoretical work undertaken principally to acquire new knowledge of the fundamental principles of phenomena and observable facts, not primarily directed towards a specific practical aim or objective.

(h) "Use" means:
-operation
-installation (including on-site installation)
-maintenance
-repair
-overhaul
-refurbishing

3. Terminology

Where the following terms appear in the text, they are to be understood acording to the explanations below:

(a) "Specially Designed" describes equipment, parts components or software which, as a result of "Development", have unique properties that distinguish them for certain predetermined purposes. For example, a piece of equipment that is "specially designed" for use in a missile will only be considered so if it has no other function or use. Similarly, a piece of manufacturing equipment that is "specially designed" to produce a certain type of component will only be considered such if it is not capable of producing other types of components.

(b) "Designed or Modified" describes equipment, parts, components or software which, as a result of "Development", or modification, have specified properties that make them fit for a particular application. "Designed or Modified" equipment, parts, components or software can be used for other applications. For example, a titanium coated pump designed for a missile may be used with corrosive fluids other than propellants.

(c) "Usable In" or "Capable Of" describes equipment, parts, components or software which are suitable for a particular purpose. There is no need for the equipment, parts, components or software to have been configured, modified or specified for the particular purpose. For example, any military specification memory circuit would be "capable of" operation in guidance system.

Item 1 - Category I

Complete rocket systems (including ballistic missile systems, space launch vehicles and sounding rockets) and unmanned air vehicle systems (including cruise missile systems, target drones and reconnaissance drones) capable of delivering at least a 500 kg payload to a range of at least 300 km as well as the specially designed "production facilities" for these systems.

Item 2 - Category I

Complete subsystems usable in the systems in Item 1, as follows, as well as the specially designed "production facilities" and "production equipment" therefor:

(a) Individual rocket states;

(b) Re-entry vehicles, and equipment designed or modified therefor, as follows, except as provided in Note (1) below for those designed for non-weapon payloads;

(1) Heat shields and components thereof fabricated of ceramic or ablative materials;

(2) Heat sinks and components thereof fabricated of light-weight, high heat capacity materials;

(3) Electronic equipment specially designed for re-entry vehicles;

(c) Solid or liquid propellant rocket engines, having a total impulse capacity of 1.1×10^6 N-sec (2.5×10^5 lb-sec) or greater;

(d) "Guidance sets" capable of achieving system accuracy of 3.33 per cent or less of the range (e.g, a CEP of 10 km or less at a range of 300 km), except as provided in Note (1) below for those designed for missiles with a range under 300 km or manned aircraft;

(e) Thrust vector control subsystems, except as provided in Note (1) below for those designed for rocket systems that do not exceed the range/payload capability of Item 1;

(f) Warhead safing, arming, fuzing, and firing mechanisms, except as provided in Note (1) below for those designed for systems other than those in Item 1.

Notes to Item 2:

(1) The exception in (b), (d), (e) and (f) above may be treated as Category II if the subsystem is exported subject to end use statements and quantity limits appropriate for the excepted end use stated above.

(2) CEP (circle of equal probability) is a measure of accuracy; and defined as the radius of the circle centered at the target, at a specific range, in which 50 per cent of the payloads impact.

(3) A 'guidance set' integrates the process of measuring and computing a vehicle's position and velocity (i.e, navigation) with that of computing and sending commands to the vehicle's flight control systems to correct the trajectory.

(4) Examples of methods of achieving thrust vector control which are covered by (e) include:
a. Flexible nozzle;
b. Fluid or secondary gas injection;
c. Movable engine or nozzle;
d. Deflection of exhaust gas stream (jet vanes or probes); or
e. Use of thrust tabs.

Item 3 - Category II

Propulsion components and equipment usable in the system in Item 1, as follows, as well as the specially designed "production facilities" and "production equipment" therefor:

(a) Lightweight turbojet and turbofan engines (including turbocompound engines) that are small and fuel efficient;

(b) Ramjet/scramjet/pulse jet/combined cycle engines, including devices to regulate combustion, and specially designed components therefor;

(c) Rocket motor cases, "interior lining", "insulation" and nozzles therefor;
(d) Staging mechanisms, separation mechanisms, and interstages therefor;
(e) Liquid and slurry propellant (including oxidizers) control systems, and specially designed components therefor, designed or modified to operate in vibration environments of more than 10 g RMS between 20 and 2,000 Hz.
(f) Hybrid rocket motors and specially designed components therefor.

Notes to Item 3:

(1) "Production equipment" in the heading to this includes the following:

Flow-forming machines, and specially designed components and specially designed software therefor, which:

(a) according to the manufacturer's technical specifications, can be equipped with numerical control units or a computer control, even when not equipped with such units at delivery, and

(b) with more than two axes which can be coordinated simultaneously for contouring control.

Technical Note:

Machines combining the function of spin-forming and flow-forming are for the purpose of this item regarded as flow-forming machines.

(2) Item 3(a) engines may be exported as part of a manned aircraft or in quantities appropriate for replacement parts for manned aircraft.

(3) In Item 3(c), "interior lining" suited for the bond interface between the solid propellant and the case or insulating liner is usually a liquid polymer based dispersion of refractory or insulating materials. e.g., carbon filled HTPB or other polymer with added curing agents to be sprayed or screeded over a case interior.

(4) In Item 3(c), "insulation" intended to be applied to the components of a rocket motor, ie, the case, nozzle inlets, case closures, includes cured or semi-cured compounded rubber sheet stock containing an insulating or refractory material. It may also be incorporated as stress reflief boots or flaps.

(5) The only servo valves and pumps covered in (e) above, are the following:

a. Servo valves designed for flow rates of 24 litres per minute or greater, at an absolute pressure of 7,000 kPa (1,000 psi) or greater, that have an actuator response time of less than 100 msec;

b. Pumps, for liquid propellants, with shaft speeds equal to or greater than 8,000 rpm or with discharge pressures equal to or greater than 7,000 kPa (1,000 psi).

(6) Item 3(e) systems and components may be exported as part of a satellite.

Item 4- Category II

Propellants and constituent chemicals for propellants as follows:

(a) Propulsive substances:

(1) Hydrazine with a concentration of more than 70 per cent and its derivatives including monomethylhydrazine (MMH);
(2) Unsymmetric dimethylhydrazine (UDMH);
(3) Ammonium perchlorate;
(4) Spherical aluminium powder with particles of uniform diameter of less than 500×10^{-6} m (500 micrometer) and an aluminium content of 97 per cent or greater;
(5) Metal fuels in particle sizes less than 500×10^{-6} m (500 microns), whether spherical, atomized, spheroidal, flaked or ground, consisting of 97 per cent or more of any of the following: zirconium, beryllium, boron, magnesium, zinc and alloys of these; Misch metal;
(6) Nitro-amines (cyclotetramethylene-tetranitramine (HMX), cyclotetramethylenetrinitramine (RDX);
(7) Perchlorates, chlorates or chromates mixed with powered metals or other high energy fuel components;
(8) Carboranes, decaboranes, pentaboranes and derivatives therefor;
(9) Liquid oxidizers, as follows:
(i) Dinitrogen trioxide;
(ii) Nitrogen dioxide/dinitrogen tetroxide;
(iii) Dinitrogen pentoxide;
(iv) Inhibited Red Fuming Nitric Acid (IRFNA);
(v) Compounds composed of fluorine and one or more of other halogens, oxygen or nitrogen.

(b) Polymeric substances:

(1) Carboxy-terminated polybutadiene (CTPB);
(2) Hydroxy-terminated polybutadiene (HTPB);
(3) Glycidyl azide polymer (GAP);
(4) Polybutadiene-acrylic acid (PBAA);
(5) Polybutadiene-acrylic acid-acrylonitrile (PBAN).

(c) Composite propellants including moulded glue propellants and propellants with nitrated bonding.

(d) Other high energy density propellants such as, Boron Slurry, having an energy density of 40×10^6 joules/kg or greater.

(e) Other propellant additives and agents:

(1) Bonding agents as follows:
(i) tris (1-(2-methyl)aziridinyl)phosphine oxide (MAPO);
(ii) trimesoyl-1(2-ethyl)aziridine (HX-868 BITA);
(iii) 'Tepanol' (HX-878). Reaction product of tetraethlylenepentamine, acrylonitrile and glycidol;
(iv) 'Tepan' (HX-879). Reaction production of tetlenepentamine and acrylonitrile;

(v) Polyfunctional aziridene amides with isophthalic, trimesic, isocyanuric, or trimethyladipic backbone also having a 2-methyl or 2-ethyl aziridine group (HX-752. HX-874 and HX-877).

(2) Curing agents and catalysts as follows:
(i) Triphenyl bismuth (TPB);
(ii) Isophoron diisocyanate (IPDI).

(3) Burning rate modifiers as follows:
(i) Catocene;
(ii) N-butyl-ferrocene;
(iii) Butacene;
(iv) Other ferrocene derivatives.

(4) Nitrate esters and nitrato plasticizers as follows:
(i) Triethylene glycol dinitrate (TEGDN);
(ii) Trimethylolethane trinitrate (TEGDN);
(iii) 1, 2, 4-butanetriol trinitrate (BTTN);
(iv) Diethylene glycol dinitrate (DEGDN).
(5) Stabilizers as follows:
(i) 2 - nitrodiphenylamine;
(ii) N - methyl-p-nitroaniline.

Item **5** -Category **II**
Production technology, or "production equipment" (including its specially designed components) for:

(a) Production, handling or acceptance testing of liquid propellants or propellant constituents described in Item 4.

(b) Production, handling, mixing, curing, casting, pressing, machining, extruding or acceptance testing of solid propellants or propellant constituents in Item 4.

Notes to Item 5:

(1) Batch mixers or continuous mixers covered by (b) above, both with provision for mixing under vacuum in the range of zero to 13.326 kPa with temperature control capability of the mixing chamber, are the following:

Batch mixers having:
a. A total volumetric capacity of 110 litres (30 gallons) or more; and
b. At least one mixing/kneading shaft mounted off centre.
Continuous mixers having:
a. Two or more mixing/kneading shafts; and
b. Capability to open the mixing chamber.

(2) The following equipment is included in (b) above:
a. Equipment for the production of atomized or spherical metallic powder in a controlled environment;
b. Fluid energy mills for grinding or milling ammonium perchlorate, RDX, or HMX.

Item **6** -Category **II**
Equipment, " technical-data" and procedures for the production of structural composites usable in the systems in Item 1 as follows and specially designed components, and accessories and specially designed software therefor:

(a) Filament winding machines of which the motions for positioning, wrapping and winding fibres are coordinated and programmed in three or more axes, designed to fabricate composite structures or laminates from fibrous and filamentary materials, and coordinating and programming controls;

(b) Tape-laying machines of which the motions for positioning and laying tape and sheets are coordinated and programmed in two or more axes, designed for the manufacture of composite airframes and missile structures;

(c) Interlacing machines, including adapters and modification kits for weaving, interlacing or braiding fibres designed to fabricate composite structures, except textile machinery which has not been modified for the above end uses;

(d) Equipment designed or modified for the production of fibrous and filamentary materials as follows;

(1) Equipment for converting polymeric fibres (such as polyacrylonitrile, rayon or polycarbosilane) including special provision to strain the fibre during heating;

(2) Equipment for the vapor deposition of elements or compounds on heated filament substrates; and

(3) Equipment for the wet-spinning of refractory ceramics (such as aluminium oxide);

(e) Equipment designed or modified for special fibre surface treatment or for producing prepregs and preforms.

(f) Technical data (including processing conditions) and procedures for the regulation of temperature, pressures or atmosphere in autoclaves or hydroclaves when used for the production of composites or partially processed composites.

Note to Item **6:**

(1) Examples of components and accessories for the machines covered by this entry are: moulds, mandrels, dies, fixtures and tooling for the preform pressing, curing, casting, sintering or bonding of composite structures, laminates and manufactures thereof.

(2) Equipment covered by subitem (e) includes but is not limited to rollers, tension stretchers, coating equipment, cutting equipment and clicker dies.

Item **7** - Category **II**
Pyrolytic deposition and densification equipment and "technology" as follows:

(a) 'Technology' for producing pyrolytically derived materials formed on a mould, mandrel or other substrate from precursor gases which decompose in the 1,300 degrees C to 2,900 degrees C

temperature range at pressures of 130 Pa (1 mm Hg) to 20 kPa (150 mm Hg) including technology for the composition of precursor gases, flow-rates and process control schedules and parameters;
(b) Specially designed nozzles for the above processes;
(c) Equipment and process controls, and specially designed software therefor, designed or modified for densification and pyrolysis of structural composite rocket nozzles and re-entry vehicle nose tips.

Notes to Item *7:*
(1) Equipment included under (c) above are isostatic presses having all of the following characteristics:
a. Maximum working pressure of 69 MPa (10,000 psi) or greater;
b. Designed to achieve and maintain a controlled thermal environment of 600 degrees C or greater; and
c. Possessing a chamber cavity with an inside diameter of 254 mm (10 inches) or greater.
(2) Equipment included under (c) above are chemical vapour deposition furnances designed or modified for the densification of carbon-carbon composites.

Item ***8*** - Category **II**
Structural materials usable in the system in Item *1,* as follows;
(a) Composite structures, laminates, and manufactures thereof, including resin impregnated fibre prepregs and metal coated fibre preforms therefor, specially designed for use in the systems in Item 1 and the subsystems in Item 2 made either with organic matrix or metal matrix utilizing fibrous or filamentary reinforcements having a specific tensile strength greater than 7.62 x 10^4 m (3 x 10^6 inches) and in specific modulus greater than 3.18 x 10^6 m (1.25 x 10^8 inches):
(b) Resaturated pyrolized (ie carbon-carbon) materials designed for rocket systems;
(c) Fine grain recrystallized bulk graphites (with a bulk density of at least 1.72 g/cc measured at 15 degrees C), pyrolytic, or fibrous reinforced graphites usable for rocket nozzles and re-entry vehicle nose tips;
(d) Ceramic composite materials (dielectric constant less than 6 at frequencies from 100 Hz to 10,000 MHz) for use in missile radomes, and bulk machinable silicon-carbide reinforced unfired ceramic usable for nose tips;
(e) Tungsten, molybdenum and alloys of these metals in the form of uniform spherical or atomized particles of 500 micrometer diameter or less with a purity of 97 per cent or higher for fabrication of rocket motor components; ie heat shields, nozzles substrates, nozzle throats and thrust vector control surfaces;
(f) Maraging steels (steels generally characterized by high Nickel, very low carbon content and the use of substitutional elements to produce age-hardening) having an Ultimate Tensile Strength of 1.5 x 10^9 Pa or greater, measured at 20°C.

Note to Item ***8*** *:*
Maraging steels are only covered by 8(f) above for the purpose of this Annex in the form of sheet, plate or tubing with a wall or plate thickness equal to or less than 5.0 mm (0.2 inches).

Item **9** - Category **II**
Instrumentation. navigation and direction finding equipment and systems, and associated production and test equipment as follows; and specially designed components and software therefor:
(a) Integrated flight instrument systems, which include gyrostabilizers or automatic pilots and integration software therefor, designed or modified for use in the systems in Item 1;
(b) Gyro-astro compasses and other devices which derive position or orientation by means of automatically tracking celestial bodies or satellites;
(c) Accelerometers with a threshold of 0.05 g or less or a linearity error within 0.25 per cent of full scale output or both, which are designed for use in inertial navigation systems or in guidance systems of all types;
(d) All types of gyros usable in the systems in Item 1, with a rated drift rate stabilityof less than 0.5 degree (1 sigma or rms) per hour in a **1** g environment;
(e) Continuous output accelerometers or gyros of any type, specified to function at acceleration levels greater than 100 g;
(f) Inertial or other equipment using accelerometers described by subitems (c) and (e) above or gyros described by subitems (d) or (e) above, and systems incorporating such equipment, and specially designed integration software therefor;
(g) Specially designed test, calibration, and alignment equipment, and "production equipment" for the above, including the following:
(1) For laser gyro equipment, the following equipment used to characterize mirrors, having the threshold accuracy shown or better:
(i) Scatterometer (10 ppm);
(ii) Reflectometer (50 ppm);
(iii) Profilometer (5 Angstroms).
(2) For other inertial equipment:
(i) Inertial Measurement Unit (IMU Module) Tester;
(ii) IMU Platform Tester;
(iii) IMU Stable Element Handling Fixture;
(iv) IMU platform balance fixture;
(v) Gyro Tuning Test Station;
(vi) Gyro Dynamic Balance Station;
(vii) Gyro Run-In/Motor Test Station;
(viii) Gyro Evacuation and Filling Station;
(ix) Centrifuge Fixture for Gyro Bearings;
(x) Accelerometer Axis Align Station;
(xi) Accelerometer Test Station.

Notes to Item 9:
(1) Item (a) through (f) may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.
(2) In subi tem (d):

a. Drift rate is defined as the time rate of output deviation from the desired output. It consists of random and systematic components and is expressed as an equivalent angular displacement per unit time with respect to inertial space.

b. Stability is defined as standard deviation (1 sigma) of the variation of a particular parameter from its calibrated value measured under stable temperature conditions. This can be expressed as a function of time.

Item 10 - Category II
Flight control systems and "technology" as follows; designed or modified for the systems in Item 1 as well as the specially designed test, calibration, and alignment equipment therefor:

(a) Hydraulic, mechanical, electro-optical, or electro-mechanical flight control systems (including fly-by-wire systems);

(b) Attitude control equipment;

(c) Design technology for integration of air vehicle fuselage, propulsion system and lifting control surfaces to optimize aerodynamic performance throughtout the flight regime of an unmanned air vehicle;

(d) Design technology for integration of the flight control, guidance, and propulsion data into a flight management system for optimization of rocket system trajectory.

Note of Item 10:
Items (a) and (b) may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.

Item 11 - Category II
Avionics equipment, "technology" and components as follows; designed or modified for use in the systems in Item 1, and specially designed software therefor:

(a) Radar and laser radar systems, including altimeters;

(b) Passive sensors for determining bearings to specific electromagnetic sources (direction finding equipment) or terrain characteristics;

(c) Global Positioning Systems (GPS) or similar satellite receivers;

(1) Capable of providing navigation information under the following operational conditions;

(i) At speeds in excess of 515 m/sec (1000 nautical miles/hour); and

(ii) At altitudes in excess of 18 km (60,000 feet); or

(2) Designed or modified for use with unmanned air vehicles covered by Item 1.

(d) Electronic assemblies and components specially designed for military use and operation at temperatures in excess of 125 degrees C.

(e) Design technology for protection of avionics and electrical subsystems against electromagnetic pulse (EMP) and electromagnetic interference (EMI) hazards from external sources, as follows:

(1) Design technology for shielding systems;

(2) Design technology for the configuration of hardened electrical circuits and subsystems;

(3) Determination of hardening criteria for the above.

Notes to Item 11:
(1) Item 11 equipment may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.
(2) Examples of equipment included in this Item:

a. Terrain contour mapping equipment;
b. Scene mapping and correlation (both digital and analogue) equipment;
c. Doppler navigation radar equipment;
d. Passive interferometer equipment;
e. Imaging sensor equipment (both active and passive);

(3) In subitem (a), laser radar systems embody specialized transmission, scanning, receiving and signal processing techniques for utilization of lasers for echo ranging, direction finding and discrimination of targets by location, radial speed and body reflection characteristics.

Item 12 - Category II
Launch support equipment, facilities and software for the systems in Item 1, as follows:

(a) Apparatus and devices designed or modified for the handling, control, activation and launching of the systems in Item 1;

(b) Vehicles designed or modified for the transport, handling, control, activation and launching of the systems in Item 1;

(c) Gravity meters (gravimeters), gravity gradiometers, and specially designed components therefor, designed or modified for airborne or marine use, and having a static or operational accuracy of 7×10^{-6} m/sec^2 (0.7 milligal) or better, with a time to steady-state registration of two minutes or less;

(d) Telemetering and telecontrol equipment usable for unmanned air vehicles or rocket systems;

(e) Precision tracking systems:

(1) Tracking systems which use a translator installed on the rocket system or unmanned air vehicle in conjunction with either surface or airborne references or navigation satellite systems to provide real-time measurements of in-flight position and velocity;

(2) Range instrumentation radars including associated optical/infrared trackers and the specially designed software therefor with the following capabilities:

(i) an angular resolution better than 3 milli-radians (0.5 mils);

(ii) and a range of 30 km or greater with a range resolution better than 10 m RMS;

(iii) and a velocity resolution better than 3 metres per second.

(3) Software which processes, post-flight, recorded data, enabling determination of vehicle position throughout its flight path.

Item 13 - Category II
Analogue computers, digital computers, or digital differential analyzers designed or modified for use in the systems in Item 1, having either of the following characteristics:
(a) Rated for continuous operation at temperatures form below minus 45 degrees C to above plus 55 degrees C; or
(b) Designed as ruggedized or "radiation hardened".

Note to Item 13:
Item 13 equipment may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.

Item 14 - Category II
Analogue-to-digital converters, usable in the systems in Item 1, having either of the following characteristics:
(a) Designed to meet military specifications for ruggedized equipment; or
(b) Designed or modified for military use; and being one of the following types:
1) Analogue-to-digital converter "microcircuits", which are "radiation-hardened" or have all of the following characteristics:
i) Having a resolution of 8 bits or more;
ii) Rated for operation in the temperature range from below minus 54 degrees C to above plus 125 degrees C; and
iii) Hermetically sealed.
2) Electrical input type analogue-to-digital converter printer circuit boards or modules, with all of the following characteristics:
i) Having a resolution of *8* bits or more;
ii) Rated for operation in the temperature range from below minus 45 degrees C to above 55 degrees C; and
iii) Incorporating "microcircuits" listed in (1), above.

Item 15 - Category II
Test facilities and test equipment usable for the systems in Item 1 and Item 2 as follows; and specially designed software therefore:
(a) Vibration test equipment using digital control techniques, and feedback or closed loop test equipment therefor, capable of vibrating a system at 10 g RMS or more between 20 Hz and 2,000 Hz and imparting forces of 50 kN (11,250 lbs) or greater;
(b) Wind-tunnels for speeds of M0.9 or more;
(c) Test benches/stands which have the capacity to handle solid or liquid propellant rockets or rocket motors of more than 90 kN (20,000 lbs) of thrust, or which are capable of simultaneously measuring the three axial thrust components;
(d) Environmental chambers and anechoic chambers capable of simulating the following flight conditions:
(1) Altitude of 15,000 meters or greater; or
(2) Temperature of at least minus 50 degrees C to plus 125 degrees C; and either
(3) Vibration environments of 10g RMS or greater between 20 Hz and 2,000 Hz imparting forces of *6* kN or greater, for environmental chambers; or
(4) Acoustic environments at an overall sound pressure level of 140 dB or greater (referenced to 2 x 10^{-5} N per square metre) or with a rated power output of 4 kW or greater, for anechoic chambers.
(e) Radiographic equipment capable of delivering electromagnetic radiation produced by "bremsstrahlung" from accelerated electrons of 2 MeV or greater or by using radioactive sources of 1 MeV or greater, except those specially designed for medical purposes.

Note to Item 15(a):
The term "digital control" refers to equipment, the functions of which are, partly or entirely, automatically controlled by stored and digitally coded electrical signals.

Item 16 - Category II
Specially designed software, or specially designed software with related specially designed hybrid (combined analogue/digital) computers, for modelling, simulation, or design integration of the systems in Item 1 and Item 2.

Note to Item 16:
The modelling includes in particular the aerodynamic and thermodynamic analysis of the system

Item 17 - Category II
Materials, devices, and specially designed software for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures (ie stealth technology), for applications usable for the system in Item 1 or Item 2, for example:
(a) Structural materials and coatings specially designed for reduced radar reflectivity;
(b) Coatings, including paints, specially designed for reduced or tailored reflectivity or emissivity in the microwave, infrared or ultraviolet spectra, except when specially used for thermal control of satellites;
(c) Specially designed software or databases for analysis of signature reduction;
(d) Specially designed radar cross section measurement systems.

Item 18 - Category II

Devices for use in protecting rocket systems and unmanned air vehicles against nuclear effects (eg Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for the systems in Item 1, as follows:

(a) "Radiation Hardened" "microcircuits" and detectors.

(b) Radomes designed to withstand a combined thermal shock greater than 100 cal/sq cm accompanied by a peak over pressure of greater than 50 kPa (7 pounds per square inch).

Note to Item 18 (a):

A detector is defined as a mechanical, electrical, optical or chemical device that automatically identifies and records, or registers a stimulus such as an environmental change in pressure or temperature, an electrical or electromagnetic signal or radiation from a radioactive material.

Item 19 - Category II

Complete rocket systems (including ballistic missile systems, space launch vehicles and sounding rockets) and unmanned air vehicles (including cruise missile system, target drones and reconnaissance drones), not covered in Item 1, capable of a maximum range equal or superior to 300 km.

Item 20 - Category II

Complete subsystems as follows, usable in systems in Item 19, but not in systems in Item 1, as well as specially designed "production facilities" and "production equipment" therefor:

(a) Individual rocket stages

(b) Solid or liquid propellant rocket engines, having a total impulse capacity of 8.41×10^5 Ns (1.9×10^5 lb.s) or greater, but less than 1.1×10^6 Ns (2.5×10^5 lb.s).

Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter Range Missiles (INF)

7 December 1987

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Conscious that nuclear war would have devastating consequences for all mankind,

Guided by the objective of strengthening strategic stability,

Convinced that the measures set forth in this Treaty will help to reduce the risk of outbreak of war and strengthen international peace and security, and

Mindful of their obligations under Article VI of the Treaty on the Non-Proliferation of Nuclear Weapons,

Have agreed as follows:

Article I

In accordance with the provisions of this Treaty which includes the Memorandum of Understanding and Protocols which form an integral part thereof, each Party shall eliminate its intermediate range and shorter range missiles, not have such systems thereafter, and carry out the other obligations set forth in this Treaty.

Article II

For the Purposes of this Treaty:

1. The term 'ballistic missile' means a missile that has a ballistic trajectory over most of its flight path. The term 'Ground-Launched Ballistic Missile (GLBM)' means a ground-launched ballistic missile that is a weapon-delivery vehicle.
2. The term 'cruise missile' means an unmanned, self-propelled vehicle that sustains flight through the use of aerodynamic lift over most of its flight path. The term 'Ground-Launched Cruise Missile (GLCM)' means a ground-launched cruise missile that is a weapon-delivery vehicle.
3. The term 'GLBM launcher' means a fixed launcher or a mobile land-based transporter-erector-launcher mechanism for launching a GLBM.
4. The term 'GLCM launcher' means a fixed launcher or a mobile land-based transporter-erector-launcher mechanism for launching a GLCM.
5. The term 'intermediate range missile' means a GLBM or a GLCM having a range capability in excess of 1,000 kilometers but not in excess of 5,500 kilometers.
6. The term 'shorter range missile' means a GLBM or GLCM having a range capability equal to or in excess of 500 kilometers but not in excess of 1,000 kilometers.
7. The term 'deployment area' means a designated area within which intermediate range missiles and launchers of such missiles may operate and within which one or more missile operating bases are loocated.
8. The term 'missile operating base' means:
   (a) in the case of intermediate range missiles, a complex of facilities located within a deployment area at which intermediate range missiles and launchers of such missiles normally operate, in which support structures associated with such missiles and launchers are also located and in which support equipment associated with such missiles and launchers is normally located; and
   (b) in the case of shorter range missiles, a complex of facilities located any place at which shorter range missiles and launchers of such missiles normally operate and in which support equipment associated with such missiles and launchers is normally located.
9. The term 'missile support facility', as regards intermediate range or shorter range missiles and launchers of such missiles, means a missile production facility or a launcher production facility, a missile repair facility or a launcher repair facility, a training facility, a missile storage facility, or a launcher storagefacility, a test range, or an elimination facility as those terms are defined in the Memorandum of Understanding.
10. The term 'transit' means movement, notified in accordance with paragraph 5(f) of Article IX of this Treaty, of an intermediate range missile or a launcher of such a missile between missile support facilities, between such a facility and a deployment area or between deployment areas, or of a shorter range missile or a launcher of such a missile from a missile support facility or missile operating base to an elimination facility.
11. The term 'deployed missile' means an intermediate range missile located within a deployment area or a shorter range missile located at a missile operating base.
12. The term 'non-deployed missile' means an intermediate range missile located outside a deployment area or a shorter range missile located outside a missile operating base.
13. The term 'deployed launcher' means a launcher of an intermediate range missile located within a deployment area or a launcher of a shorter range missile located at a missile operating base.
14. The Term 'non-deployed launcher' means a launcher of an intermediate range missile located outside a deployment area or a launcher of a shorter range missile located outside a missile operating base.
15. The term 'basing country' means a country other than the United States of America or the Union of Soviet Socialist Republics on whose territory intermediate range or shorter range missiles of the Parties, launchers of such missiles or support structures associated with such missiles and launchers were located at any time after 1 November 1987. Missiles or launchers in transit are not considered to be 'located'.

Article III

1. For the purposes of this Treaty, existing types of intermediate range missiles are:

(a) for the United States of America, missiles of the types designated by the United States of America as the Pershing II and the BGM-109G, which are known to the Union of Soviet Socialist Republics by the same designations; and

(b) for the Union of Soviet Socialist Republics, missiles of the types designated by the Union of Soviet Socialist Republics as the RSD-10, the R-12 and the R-14, which are known to the United States of America as the SS-20. the SS-4 and the SS-5, respectively.

2. For the purposes of this Treaty, existing types of shorter range missiles are:

(a) for the United States of America, missiles of the type designated by the United States of America as the Pershing IA, which is known to the Union of Soviet Socialist Republics by the same designation; and

(b) for the Union of Soviet Socialist Republics, missiles of the types designated by the Union of Soviet Socialist Republics as the OTR-22 and the OTR-23, which are known to the United States of America as the SS-12 and the SS-23, respectively.

Article IV

1. Each Party shall eliminate all its intermediate range missiles and launchers of such missiles, and all support structures and support equipment of the categories listed in the Memorandum of Understanding associated with such missiles and launchers, so that no later than three years after entry into force of this Treaty and thereafter no such missiles, launchers, support structures or support equipment shall be possessed by either Party.

2. To implement paragraph 1 of this Article, upon entry into force of this Treaty, both Parties shall begin and continue throughout the duration of each phase, the reduction of all types of their deployed and non-deployed intermediate range missiles and deployed and non-deployed launchers of such missiles and support structures and support equipment associated with such missiles and launchers in accordance with the provisions of this Treaty. These reductions shall be implemented in two phases *so* that:

(a) by the end of the first phase, that is, no later than 29 months after entry into force of this Treaty:

(i) the number of deployed launchers of intermediate range missiles for each Party shall not exceed the number of launchers that are capable of carrying or containing at one time missiles considered by the Parties to carry 171 warheads;

(ii) the number of deployed intermediate range missiles for each Party shall not exceed the number of such missiles considered by the Parties to carry 180 warheads;

(iii) the aggregate number of deployed and non-deployed launchers of intermediate range missiles for each Party shall not exceed the number of launchers that are capable of carrying or containing at one time missiles considered by the Parties to carry 200 warheads;

(iv) the aggregate number of deployed and non-deployed intermediate range missiles for each Party shall not exceed the number of such missiles considered by the Parties to carry 200 warheads; and

(v) the ratio of the aggregate number of deployed and non-deployed intermediate range GLBMs of existing types for each Party to the aggregate number of deployed and non-deployed intermediate range missiles of existing types possessed by that Party shall not exceed the ratio of such intermediate range GLBMs to such intermediate range missiles for that Party as of 1 November 1987, as set forth in the Memorandum of Understanding; and

(b) by the end of the second phase, that is, no later than three years after entry into force of this Treaty, all intermediate range missiles of each Party, launchers of such missiles and all support structures and support equipment of the categories listed in the Memorandum of Understanding associated with such missiles and launchers, shall be eliminated.

Article V

1. Each Party shall eliminate all its shorter range missiles and launchers of such missiles, and all support equipment of the categories listed in the Memorandum of Understanding associated with such missiles and launchers, so that no later than 18 months after entry into force of this Treaty and thereafter no such missiles, launchers or support equipment shall be possessed by either Party.

2. No later than 90 days after entry into force of this Treaty, each Party shall complete the removal of all its deployed shorter range missiles and deployed and non-deployed launchers of such missiles to elimination facilities and shall retain them at those locations until they are eliminated in accordance with the procedures set forth in the Protocol on Elimination. No later than 12 months after entry into force of this Treaty, each Party shall complete the removal of all its non-deployed shorter range missiles to elimination facilities and shall retain them at those locations until they are eliminated in accordance with the procedures set forth in the Protocol on Elimination.

3. Shorter range missiles and launchers of such missiles shall not be located at the same elimination facility. Such facilities shall be separated by no less than 1,000 kilometers.

Article VI

1. Upon entry into force of this Treaty and thereafter, neither Party shall:

(a) produce or flight-test any intermediate range missiles of produce any stages of such missiles or any launchers of such missiles; or

(b) produce, flight-test or launch any shorter range missiles or produce any stages of such missiles or any launchers of such missiles.

2. Notwithstanding paragraph 1 of this Article, each Party shall have the right to produce a type of GLBM not limited by this Treaty which uses a stage which is outwardly similar to, but not interchangeable with, a stage of an existing type of intermediate range GLBM having more than one stage, providing that that Party shall not produce any other stage which is outwardly similar to, but not interchangeable with, any other stage of an existing type of intermediate range GLBM.

Article VII

For the purposes of this Treaty:
1. If a ballistic missile or a cruise missile has been flight-tested or deployed for weapon-delivery, all missiles of that type shall be considered to be weapon-delivery vehicles.
2. If a GLBM or GLCM is an intermediate range missile, all GLBMs or GLCMs of that type shall be considered to be intermediate range missiles. If a GLBM or GLCM is a shorter range missile, all GLBMs or GLCMs of that type shall be considered to be shorter range missiles.
3. If a GLBM is of a type developed and tested solely to intercept and counter objects not located on the surface of the Earth, it shall not be considered to be a missile to which the limitations of the Treaty apply.
4. The range capability of a GLBM not listed in Article III of this Treaty shall be considered to be the maximum range to which it has been tested. The range capability of a GLCM not listed in Article III of this Treaty shall be considered to be the maximum distance which can be covered by the missile in its standard design mode flying until fuel exhaustion, determined by projecting its flight path onto the Earth's sphere from the point of launch to the point of impact. GLBMs or GLCMs that have a range capability equal to or in excess of 500 kilometers but not in excess of 1,000 kilometers shall be considered to be shorter range missiles. GLBMs or GLCMs that have a range capability in excess of 1,000 kilometers but not in excess of 5,500 kilometers shall be considered to be intermediate range missiles.
5. The maximum number of warheads an existing type of intermediate range missile or shorter range missile carries shall be considered to be the number listed for missiles of that type in the Memorandum of Understanding.
6. Each GLBM or GLCM shall be considered to carry the maximum number of warheads listed for a GLBM or GLCM of that type in the Memorandum of Understanding.
7. If a launcher has been tested for launching a GLBM or a GLCM, all launchers of that type shall be considered to have been tested for launching GLBMs or GLCMs.
8. If a launcher has contained or launched a particular type of GLBM or GLCM, all launchers of that type shall be considered to be launchers of that type of GLBM or GLCM.
9. The number of missiles each launcher of an existing type of intermediate range missile or shorter range missile shall be considered to be capable of carrying or containing at one time is the number listed for launchers of missiles of that type in the Memorandum of Understanding.
10. Except in the case of elimination in accordance with the procedures set forth in the Protocol on Elimination, the following shall apply:

(a) for GLBMs which are stored or moved in separate stages, the longest stage of an intermediate range or shorter range GLBM shall be counted as a complete missile;

(b) for GLBMs which are not stored or moved in separate stages, a canister of the type used in the launch of an intermediate range GLBM, unless a Party proves to the satisfaction of the other Party that it does not contain such a missile, or an assembled intermediate range or shorter range GLBM, shall be counted as a complete missile; and

(c) for GLCMs, the airframe of an intermediate range or shorter range GLCM shall be counted as a complete missile.

11. A ballistic missile which is not a missile to be used in a ground-based mode shall not be considered to be a GLBM if it is test-launched at a test site from a fixed land-based launcher which is used solely for test purposes and which is distinguishable from GLBM launchers. A cruise missile which is not a missile to be used in a ground-based mode shall not be considered to be a GLCM if it is test-launched at a test site from a fixed land-based launcher which is used solely for test purposes and which is distinguishable from GLCM launchers.
12. Each Party shall have the right to produce and use for booster systems, which might otherwise be considered to be intermediate range or shorter range missiles, only existing types of booster stages for such booster systems. Launches of such booster systems shall not be considered to be flight-testing of intermediate range or shorter range missiles provided that:

(a) stages used in such booster systems are different from stages used in those missiles listed as existing types of intermediate range or shorter range missiles in Article III of this Treaty;

(b) such booster systems are used only for research and development purposes to test objects other than the booster systems themselves;

(c) the aggregate number of launchers for such booster systems shall not exceed 35 for each Party at any one time; and

(d) the launchers for such booster systems are fixed, emplaced above ground and located only at research and development launch sites which are specified in the Memorandum of Understanding.

Research and development launch sites shall not be subject to inspection pursuant to Article XI of this Treaty.

Article VIII

1. All intermediate range missiles and launchers of such missiles shall be located in deployment areas, at missile support facilities or shall be in transit. Intermediate range missiles or launchers of such missiles shall not be located elsewhere.
2. Stages of intermediate range missiles shall be located in deployment areas, at missile support facilities or moving between deployment areas, between missile support facilities or between missile support facilities and deployment areas.
3. Until their removal to elimination facilities as required by paragraph 2 of Article V of this Treaty, all shorter range missiles and launchers of such missiles shall be located at missile operating bases, at

missile support facilities or shall be in transit. Shorter range missiles or launchers of such missiles shall not be located elsewhere.
4. Transit of a missile or launcher subject to the provisions of this Treaty shall be completed within 25 days.
5. All deployment areas, missile operating bases and missile support facilities are specified in the Memorandum of Understanding or in subsequent updates of data pursuant to paragraphs 3, 5(a) or 5(b) of Article IX of this Treaty. Neither Party shall increase the number of, or change the location or boundaries of, deployment areas, missile operating bases or missile support facilities, except for elimination facilities, from those set forth in the Memorandum of Understanding. A missile support facility shall not be considered to be part of a deployment area even though it may be located within the geographic boundaries of a deployment area.
6. Beginning 30 days after entry into force of this Treaty, neither Party shall locate intermediate range or shorter range missiles, including stages of such missiles, or launchers of such missiles at missile production facilities, launcher production facilities or test ranges listed in the Memorandum of Understanding.
7. Neither Party shall locate any intermediate range or shorter range missiles at training facilities.
8. A non-deployed intermediate range or shorter range missile shall not be carried on or contained within a launcher of such a type of missile, except as required for maintenance conducted at repair facilities or for elimination by means of launching conducted at elimination facilities.
9. Training missiles and training launchers for intermediate range or shorter range missiles shall be subject to the same locational restrictions as are set forth for intermediate range and shorter range missiles and launchers of such missiles in paragraphs 1 and 3 of this Article.

Article IX

1. The Memorandum of Understanding contains categories of data relevant to obligations undertaken with regard to this Treaty and lists all intermediate range and shorter range missiles, launchers of such missiles, and support structures and support equipment associated with such missiles and launchers, possessed by the Parties as of 1 November 1987. Updates of that data and notifications required by this Article shall be provided according to the categories of data contained in the Memorandum of Understanding.
2. The Parties shall update that data and provide the notifications required by this Treaty through the Nuclear Risk Reduction Centres, established pursuant to the Agreement Between the United States of America and the Union of Soviet Socialist Republics on the Establishment of Nuclear Risk Reduction Centres of 15 September 1987.
3. No later than 30 days after entry into force of this Treaty, each Party shall provide the other Party with updated data, as of the date of entry into force of this Treaty, for all categories of data contained in the Memorandum of Understanding.
4. No later than 30 days after the end of each six-month interval following the entry into force of this Treaty, each Party shall provide updated data for all categories of data contained in the Memorandum of Understanding by informing the other Party of all changes, completed and in process, in that data, which have occurred during the six-month interval since the preceding data exchange, and the net effect of those changes.
5. Upon entry into force of this Treaty and thereafter, each Party shall provide the following notifications to the other Party:

(a) notification, no less than 30 days in advance, of the scheduled date of the elimination of a specific deployment area, missile operating base or missile support facility;

(b) notification, no less than 30 days in advance, of changes in the number or location of elimination facilities, including the location and scheduled date of a change;

(c) notification, except with respect to launches of intermediate range missiles for the purpose of their elimination, no less than 30 days in advance, of the scheduled date of the initiation of the elimination of intermediate range and shorter range missiles, and stages of such missiles, and launchers of such missiles and support structures and support equipment associated with such missiles and launchers, including:

(i) the number and type of items of missile systems to be eliminated;

(ii) the elimination site;

(iii) for intermediate range missiles, the location from which such missiles, launchers of such missiles and support equipment associated with such missiles and launchers are moved to the elimination facility; and

(iv) except in the case of support structures, the point of entry to be used by an inspection team conducting an inspection pursuant to paragraph 7 of Article XI of this Treaty and the estimated time of departure of an inspection team from the point of entry to the elimination facility;

(d) notification, no less than ten days in advance, of the scheduled date of the launch, or the scheduled date of the initiation of a series of launches, of intermediate range missiles for the purpose of their elimination, including:

(i) the type of missiles to be eliminated;

(ii) location of the launch, or, if elimination is by a series of launches, the location of such launches and number of launches in the series;

(iii) the point of entry to be used by an inspection team conducting an inspection pursuant to paragraph 7 of Article XI of this Treaty; and

(iv) the estimated time of departure of an inspection team from the point of entry to the elimination facility;

(e) notification, no later than 48 hours after they occur, of changes in the number of intermediate range and shorter range missiles, launchers of such missiles and support structures and support equipment associated with such missiles and launchers resulting from elimination as described in the Protocol on Elimination, including:

(i) the number and type of items of a missile system which were eliminated; and

(ii) the date and location of such elimination; and

(f) notification of transit of intermediate range or shorter range missiles or launchers of such missiles, or the movement of training missiles or training launchers for such intermediate range and shorter range missiles, no later than 48 hours after it has been completed, including:

(i) the number of missiles or launchers:

(ii) the points, dates and times of departure and arrival:

(iii) the mode of transport; and

(iv) the location and time at that location at least once every four days during the period of transit.

6. Upon entry into force of this Treaty and thereafter, each Party shall notify the other Party, no less than ten days in advance, of the scheduled date and location of the launch of a research and development booster system as described in paragraph 12 of Article VII of this Treaty.

Article X

1. Each Party shall eliminate its intermediate range and shorter range missiles and launchers of such missiles and support structures and support equipment associated with such missiles and launchers in accordance with the procedures set forth in the Protocol on Elimination.
2. Verification by on-site inspection of the elimination of items of missile systems specified in the Protocol on Elimination shall be carried out in accordance with Article XI of this Treaty, the Protocol on Elimination and the Protocol on Inspection.
3. When a Party removes its intermediate range missiles, launchers of such missiles and support equipment associated with such missiles and launchers from deployment areas to elimination facilities for the purpose of their elimination, it shall do so in complete deployed organizational units. For the United States of America, these units shall be Pershing II batteries and BGM-109G flights. For the Union of Soviet Socialist Republics these units shall be SS-20 regiments composed of two or three battalions.
4. Elimination of intermediate range and shorter range missiles and launchers of such missiles and support equipment associated with such missiles and launchers shall be carried out at the facilities that are specified in the Memorandum of Understanding or notified in accordance with paragraph 5(b) of Article IX of this Treaty, unless eliminated in accordance with Sections IV or V of the Protocol on Elimination. Support structures associated with the missiles and launchers subject to this Treaty, that are subject to elimination shall be eliminated ***in situ.***
5. Each Party shall have the right, during the first six months after entry into force of this Treaty, to eliminate by means of launching no more than 100 of its intermediate range missiles.
6. Intermediate range and shorter range missiles which have been tested prior to entry into force of this Treaty, but never deployed, and which are not existing types of intermediate range or shorter range missiles listed in Article III of this Treaty, and launchers of such missiles, shall be eliminated within six months after entry into force of this Treaty in accordance with the procedures set forth in the Protocol on Elimination. Such missiles are:

(a) for the United States of America, missiles of the type designated by the United States of America as the Pershing IB, which is known to the Union of Soviet Socialist Republics by the same designation; and

(b) for the Union of Soviet Socialist Republics, missiles of the type designated by the Union of Soviet Socialist Republics as the RK-55, which is known to the United States of America as the SSC-x-4.

7. Intermediate range and shorter range missiles and launchers of such missiles and support structures and support equipment associated with such missiles and launchers shall be considered to be eliminated after completion of the procedures set forth in the Protocol on Elimination and upon the notification provided for in paragraph 5(e) of Article IX of this Treaty.
8. Each Party shall eliminate its deployment areas, missile operating bases and missile support facilities. A Party shall notify the other Party pursuant to paragraph 5(a) of Article IX of this Treaty once the conditions set forth below are fulfilled:

(a) all intermediate range and shorter range missiles, launchers of such missiles and support equipment associated with such missiles and launchers located there have been removed;

(b) all support structures associated with such missiles and launchers located there have been eliminated; and

(c) all activity related to production, flight-testing, training, repair, storage or deployment of such missiles and launchers has ceased there.

Such deployment areas, missile operating bases and missile support facilities shall be considered to be eliminated either when they have been inspected pursuant to paragraph 4 of Article XI of this Treaty or when 60 days have elapsed since the date of the scheduled elimination which was notified pursuant to paragraph 5(a) of Article IX of this Treaty. A deployment area, missile operating base or missile support facility listed in the Memorandum of Understanding that met the above conditions prior to entry into force of this Treaty, and is not included in the initial data exchange pursuant to paragraph 3 of Article IX of this Treaty, shall be considered to be eliminated.

9. If a Party intends to convert a missile operating base listed in the Memorandum of Understanding for use as a base associated with GLBM or GLCM systems not subject to this Treaty, then that Party shall notify the other Party, no less than 30 days in advance of the scheduled date of the initiation of the conversion, of the scheduled date and the purpose for which the base will be converted.

Article XI

1. For the purpose of ensuring verification of compliance with the provisions of the Treaty, each Party shall have the right to conduct on-site inspections. The Parties shall implement on-site inspections in accordance with this Article, the Protocol on Inspection and the Protocol on Elimination.
2. Each Party shall have the right to conduct inspections provided for by this Article both within the territory of the other Party and within the territories of basing countries.

3. Beginning 30 days after entry into force of this Treaty, each Party shall have the right to conduct inspections at all missile operating bases and missile support facilities specified in the Memorandum of Understanding other than missile production facilities, and at all elimination facilities included in the initial data update required by paragraph 3 of Article IX of this Treaty. These inspections shall be completed no later than 90 days after entry into force of this Treaty. The purpose of these inspections shall be to verify the number of missiles, launchers, support structures and support equipment and other data, as of the date of entry into force of this Treaty, provided pursuant to paragraph 3 of Article IX of this Treaty.
4. Each Party shall have the right to conduct inspections to verify the elimination, notified pursuant to paragraph 5(a) of Article IX of this Treaty, of missile operating bases and missile support facilities other than missile production facilities, which are thus no longer subject to inspections pursuant to paragraph 5(a) of this Article. Such an inspection shall be carried out within 60 days after the scheduled date of the elimination of thatfacility. If a Party conducts an inspection at a particular facility pursuant to paragraph 3 of this Article after the scheduled date of the elimination of that facility, then no additional inspection of that facility pursuant to this paragraph shall be permitted.
5. Each Party shall have the right to conduct inspections pursuant to this paragraph for 13 years after entry into force of this Treaty. Each Party shall have the right to conduct 20 such inspections per calender year during the first three years after entry into force of this Treaty, 15 such inspections per calender year during the subsequent five years, and ten such inspections per calender year during the last five years. Neither Party shall use more than half its total number of these inspections per calender year within the territory of any one basing country. Each Party shall have the right to conduct:

(a) inspections, beginning 90 days after entry into force of this Treaty, of missile operating bases, and missile support facilities other than elimination facilities and missile production facilities, to ascertain, according to the categories of data specified in the Memorandum of Understanding, the numbers of missiles, launchers, support structures and support equipment located at each missile operating base or missile support facility at the time of the inspection; and

(b) inspections of former missile operating bases and former missile support facilities eliminated pursuant to paragraph 8 of Article X of this Treaty other than former missile production facilities.

6. Beginning 30 days after entry into force of this Treaty, each Party shall have the right, for 13 years after entry into force of this Treaty, to inspect by means of continuous monitoring:

(a) the portals of any facility of the other Party at which the final assembly of a GLBM using stages, any of which is outwardly similar to a stage of a solid-propellant GLBM listed in Article III of this Treaty, is accomplished; or

(b) if a Party has no such facility, the portals of an agreed former missile production facility at which existing types of intermediate range or shorter range GLBMs were produced.

The Party whose facility is to be inspected pursuant to this paragraph shall ensure that the other Party is able to establish a permanent continuous monitoring system at that facility six months after entry into force of this Treaty or within six months of initiation of the process of final assembly described in subparagraph (a). If, after the end of the second year after entry into force of this Treaty, neither Party conducts the process of final assembly described in subparagraph (a) for a period of 12 consecutive months, then neither Party shall have the right to inspect by means of continuous monitoring any missile production facility of the other Party unless the process of final assembly as described in subparagraph (a) is initiated again. Upon entry into force of this Treaty, the facilities to be inspected by continuous monitoring shall be: in accordance with subparagraph (b), for the United States of America, Hercules Plant Number 1, at Magna, Utah; in accordance with subparagraph (a), for the Union of Soviet Socialist Republics, the Votkinsk Machine Building Plant, Udmurt Autonomous Soviet Socialist Republic, Russian Soviet Federative Socialist Republic.
7. Each Party shall conduct inspections of the process of elimination, including elimination of intermediate range missiles by means of launching, of intermediate range and shorter range missiles and launchers of such missiles and support equipment associated with such missiles and launchers carried out at elimination facilities in accordance with Article X of this Treaty and the Protocol on Elimination. Inspectors conducting inspections provided for in this paragraph shall determine that the process specified for the elimination of the missiles, launchers and support equipment have been completed.
8. Each Party shall have the right to conduct inspections to confirm the completion process of elimination of intermediate range and shorter range missiles and launchers of such missiles and support equipment associated with such missiles and launchers pursuant to Section V of the Protocol on Elimination, and of training missiles, training missile stages, training launch canisters and training launchers eliminated pursuant to Sections II, IV and V of the Protocol on Elimination.

Article XII

1. For the purpose of ensuring verification of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law.
2. Neither Party shall:

(a) interfere with national technical means of verification of the other Party operating in accordance with paragraph 1 of this Article; or

(b) use concealment measures which impede verification of compliance with the provisions of this Treaty by national means of verification carried out in accordance with paragraph 1 of this Article. This obligation does not apply to cover or concealment practices, within a deployment area, associated with normal training, maintenance and operations, including the use of environmental shelters to protect missiles and launchers.

3. To enhance observation by national technical means of verification, each Party shall have the right until a treaty between the Parties reducing and limiting strategic offensive arms enters into force, but in any event for no more than three years after entry into force of this Treaty, to request the implementation of co-operative measures at deployment bases for road mobile GLBMs with a range capability in excess of 5,500 kilometers, which are not former missile operating bases eliminated

pursuant to paragraph 8 of Article X of this Treaty. The Party making such a request shall inform the other Party of the deployment base at which co-operative measures shall be implemented. The Party whose base is to be observed shall carry out the following co-operative measures:

(a) no later than six hours after such a request, the Party shall have opened the roofs of all fixed structures for launchers located at the base, removed completely all missiles on launchers from such fixed structures for launchers and displayed such missiles on launchers in the open without using concealment measures; and

(b) the Party shall leave the roofs open and the missiles on launchers in place until twelve hours have elapsed from the time of the receipt of a request for such an observation.

Each Party shall have the right to make six such requests per calender year. Only one deployment base shall be subject to these co-operative measures at any one time.

Article XIII

1. To promote the objectives and implementation of the provisions of this Treaty, the Parties hereby establish the Special Verification Commission. The Parties agree that, if either Party so requests, they shall meet within the framework of the Special Verification Commission to:

(a) resolve questions relating to compliance with the obligations assumed: and

(b) agree upon such measures as may be necessary to improve the viability and effectiveness of this Treaty.

2. The Parties shall use the Nuclear Risk Reduction Centres, which provide for continuous communication between the Parties, to:

(a) exchange data and provide notifications as required by paragraphs 3, 4, 5 and 6 of Article IX of this Treaty and the Protocol on Elimination;

(b) provide and receive the information required by paragraph 9 of Article X of this Treaty;

(c) provide and receive notifications of inspections as required by Article XI of this Treaty and the Protocol on Inspection; and

(d) provide and receive requests for co-operative measures as provided for in paragraph 3 of Article XII of this Treaty.

Article XIV

The Parties shall comply with this Treaty and shall not assume any international obligations or undertakings which would conflict with its provisions.

Article XV

1. This Treaty shall be of unlimited duration.
2. Each Party shall, in exercising its national sovereignty, have the right to withdraw from this Treaty if it decides that extraordinary events related to the subject matter of this Treaty have jeopardized its supreme interests. It shall give notice of its decision to withdraw to the other Party six months prior to withdrawal from this Treaty. Such notice shall include a statement of the extraordinary events the notifying Party regards as having jeopardized its supreme interests.

Article XVI

Each Party may propose amendments to this Treaty. Agreed amendments shall enter into force in accordance with the procedures set forth in Article XVII governing the entry into force of this Treaty.

Article XVII

1. This Treaty, including the Memorandum of Understanding and Protocols, which form an integral part thereof, shall be subject to ratification in accordance with the constitutional procedures of each Party. This Treaty shall enter into force on the date of the exchange of instruments of ratification.
2. This Treaty shall be registered pursuant to Article 102 of the Charter of the United Nations.

Agreement Between the United States of America and the Union of Soviet Socialist Republics on Notifications of Launches of Intercontinental Ballistic Missiles and Submarine-launched Ballistic Missiles

31 May 1988

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Affirming their desire to reduce and ultimately eliminate the risk of outbreak of nuclear war, in particular, as a result of misinterpretation, miscalculation, or accident,

Believing that a nuclear war cannot be won and must never be fought,

Believing that agreement on measures for reducing the risk of outbreak of nuclear war serves the interests of strengthening international peace and security,

Reaffirming their obligations under the Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War between the United States of America and the Union of Soviet Socialist Republics of September 30, 1971, the Agreement between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on the Prevention of Incidents on and over the High Seas of May 25, 1972, and the Agreement between the United States of America and the Union of Soviet Socialist Republics on the Establishment of Nuclear Risk Reduction Centers of September 15, 1987,

Have agreed as follows:

Article I

Each Party shall provide the other Party notification, through the Nuclear Risk Reduction Centers of the United States of America and the Union of Soviet Socialist Republics, no less than twenty-four hours in advance, of the planned date, launch area, and area of impact for any launch of a strategic ballistic missile: an intercontinental ballistic missile (hereinafter "ICBM") or a submarine-launched ballistic missile (hereinafter "SLBM").

Article II

A notification of a planned launch of an ICBM or an SLBM shall be valid for four days counting from the launch date indicated in such a notification. In case of postponement of the launch date within the indicated four days, or cancellation of the launch, no notification thereof shall be required.

Article III

1. For launches of ICBMs or SLBMs from land, the notification shall indicate the area from which the launch is planned to take place.
2. For launches of SLBMs from submarines, the notification shall indicate the general area from which the missile will be launched. Such notification shall indicate either the quadrant within the ocean (that is, the ninety-degree sector encompassing approximately one-fourth of the area of the ocean) or the body of water (for example, sea or bay) from which the launch is planned to take place.
3. For all launches of ICBMs or SLBMs, the notification shall indicate the geographic coordinates of the planned impact area or areas of the reentry vehicles. Such an area shall be specified either by indicating the geographic coordinates of the boundary points of the area, or by indicating the geographic coordinates of the center of a circle with a radius specified in kilometers of nautical miles. The size of the impact area shall be determined by the notifying Party at its discretion.

Article IV

The Parties undertake to hold consultations, as mutually agreed, to consider questions relating to implementation of the provisions of this Agreement, as well as to discuss possible amendments thereto aimed at furthering the implementation of the objectives of this Agreement. Amendments shall enter into force in accordance with procedures to be agreed upon.

Article V

This Agreement shall not affect the obligations of either Party under other agreements.

Article VI

This Agreement shall enter into force on the date of its signature.
The duration of this Agreement shall not be limited.
This Agreement may be terminated by either Party upon 12 months written notice to the other Party.

DONE at Moscow on May 31, 1988, in two copies, each in the English and Russian languages, both texts being equally authentic

FOR THE UNITED STATES OF AMERICA	FOR THE UNION OF SOVIET SOCIALIST REPUBLICS
George P Shultz	Eduard A Shevardnadze

Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms (START 1)

31 July 1991

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Conscious that nuclear war would have devastating consequences for all humanity, that it cannot be won and must never be fought,

Convinced that the measures for the reduction and limitation of strategic offensive arms and the other obligations set forth in this Treaty will help reduce the risk of outbreak of nuclear war and strengthen international peace and security,

Recognizing that the interests of the Parties and the interests of international security require the strengthening of strategic stability,

Mindful of their undertakings with regard to strategic offensive arms in Article VI of the Treaty on the Non-Proliferation of Nuclear Weapons of July 1, 1968; Article XI of the Treaty on the Limitation of Anti-Ballistic Missile Systems of May 26, 1972; and the Washington Summit Joint Statement of June 1, 1990,

Have agreed as follows:

Article I

Each Party shall reduce and limit its strategic offensive arms in accordance with the provisions of this Treaty, and shall carry out the other obligations set forth in this Treaty and its Annexes, Protocols, and Memorandum of Understanding.

Article II

1. Each Party shall reduce and limit its ICBMs and ICBM launchers, SLBMs and SLBM launchers, heavy bombers, ICBM warheads, SLBM warheads, and heavy bomber armaments, so that seven years after entry into force of this Treaty and thereafter, the aggregate numbers, as counted in accordance with Article III of this Treaty, do not exceed:

(A) 1,600, for deployed ICBMs and their associated launchers, deployed SLBMs and their associated launchers, and deployed heavy bombers, including 154 for deployed heavy ICBMs and their associated launchers;

(B) 6,000, for warheads attributed to deployed ICBMs, deployed SLBMs, and deployed heavy bombers, including:

(i) 4.900, for warheads attributed to deployed ICBMs and deployed SLBMs;

(ii) 1,100, for warheads attributed to deployed ICBMs on mobile launchers of ICBMs;

(iii) 1,540, for warheads attributed to deployed heavy ICBMs.

2. Each Party shall implement the reductions pursuant to paragraph 1 of this Article in three phases, so that its strategic offensive arms do not exceed:

(A) by the end of the first phase, that is, no later than 36 months after entry into force of this Treaty, and thereafter, the following aggregate numbers:

(i) 2,100, for deployed ICBMs and their associated launchers, deployed SLBMs and their associated launchers, and deployed heavy bombers;

(ii) 9,150, for warheads attributed to deployed ICBMs, deployed SLBMs, and deployed heavy bombers;

(iii) 8,050, for warheads attributed to deployed ICBMs and deployed SLBMs;

(B) by the end of the second phase, that is, no later than 60 months after entry into force of this Treaty, and thereafter, the following aggregate numbers:

(i) 1,900, for deployed ICBMs and their associated launchers, deployed SLBMs and their associated launchers, and deployed heavy bombers;

(ii) 7.950. for warheads attributed to deployed ICBMs, deployed SLBMs, and deployed heavy bombers;

(iii) 6,750, for warheads attributed to deployed ICBMs and deployed SLBMs;

(C) by the end of the third phase, that is, no later than 84 months after entry into force of this Treaty: the aggregate numbers provided for in paragraph 1 of this Article.

3. Each Party shall limit the aggregate throw-weight of its deployed ICBMs and deployed SLBMs so that seven years after entry into force of this Treaty and thereafter such aggregate throw-weight does not exceed 3,600 metric tons.

Article III

1. For the purposes of counting toward the maximum aggregate limits provided for in subparagraphs 1(A), 2(A)(i), and 2(B)(i) of Article II of this Treaty:

(A) Each deployed ICBM and its associated launcher shall be counted as one unit; each deployed SLBM and its associated launcher shall be counted as one unit.

(B) Each deployed heavy bomber shall be counted as one unit.

2. For the purposes of counting deployed ICBMs and their associated launchers and deployed SLBMs and their associated launchers:

(A) Each deployed launcher of ICBMs and each deployed launcher of SLBMs shall be considered to contain one deployed ICBM or one deployed SLBM, respectively.

(B) If a deployed ICBM has been removed from its launcher and another missile has not been installed in that launcher, such an ICBM removed from its launcher and located at that ICBM base shall continue to be considered to be contained in that launcher.

(C) If a deployed SLBM has been removed from its launcher and another missile has not been

installed in that launcher, such an SLBM removed from its launcher shall be considered to be contained in that launcher. Such an SLBM removed from its launcher shall be located only at a facility at which non-deployed SLBMs may be located pursuant to subparagraph 9(A) or Article IV of this Treaty or be in movement to such a facility.

3. For the purposes of this Treaty, including counting ICBMs and SLBMs:

(A) For ICBMs or SLBMs that are maintained, stored, and transported in stages, the first stage of an ICBM or SLBM of a particular type shall be considered to be an ICBM or SLBM of that type.

(B) For ICBMs or SLBMs that are maintained, stored, and transported as assembled missiles without launch canisters, an assembled missile of a particular type shall be considered to be an ICBM or SLBM of that type.

(C) For ICBMs that are maintained, stored, and transported as assembled missiles in launch canisters, an assembled missile of a particular type, in its launch canister, shall be considered to be an ICBM of that type.

(D) Each launch canister shall be considered to contain an ICBM from the time it first leaves a facility at which an ICBM is installed in it until an ICBM has been launched from it or until an ICBM has been removed from it for elimination. A launch canister shall not be considered to contain an ICBM if it contains a training model of a missile or has been placed on static display. Launch canisters for ICBMs of a particular type shall be distinguishable from launch canistersfor ICBMs of a different type.

4. For the purposes of counting warheads:

(A) The number of warheads attributed to an ICBM or SLBM of each existing type shall be the number specified in the Memorandum of Understanding on the Establishment of the Data Base Relating to this Treaty, hereinafter referred to as the Memorandum of Understanding.

(B) The number of warheads that will be attributed to an ICBM or SLBM of a new type shall be the maximum number of re-entry vehicles with which an ICBM or SLBM of that type has been flight-tested. The number of warheads that will be attributed to an ICBM or SLBM of a new type with a front section of an existing design with multiple re-entry vehicles, or to an ICBM or SLBM of a new type with one re-entry vehicle, shall be no less than the nearest integer that is smaller than the result of dividing 40 per cent of the accountable throw-weight of the ICBM or SLBM by the weight of the lightest re-entry vehicle flight-tested on an ICBM or SLBM of that type. In the case of an ICBM or SLBM of a new type with a front section of a fundamentally new design, the question of the applicability of the 40 per cent rule to such an ICBM or SLBM shall be subject to agreement within the framework of the Joint Compliance and Inspection Commission. Until agreement has been reached regarding the rule that will apply to such an ICBM or SLBM, the number of warheads that will be attributed to such an ICBM or SLBM shall be the maximum number of re-entry vehicles with which an ICBM or SLBM of that type has been flight-tested. The number of new types of ICBMs or SLBMs with a front section of a fundamentally new design shall not exceed two for each Party as long as this Treaty remains in force.

(C) The number of re-entry vehicles with which an ICBM or SLBM has been flight-tested shall be considered to be the sum of the number of re-entry vehicles actually released during the flight-test, plus the number of procedures for dispensing re-entry vehicles performed during the same flight-test when no re-entry vehicle was released. A procedure for dispensing penetration aids shall not be considered to be a procedure for dispensing re-entry vehicles, provided that the procedure for dispensing penetration aids differs from a procedure for dispensing re-entry vehicles.

(D) Each re-entry vehicle of an ICBM or SLBM shall be considered to be one warhead.

(E) For the United States of America, each heavy bomber equipped for long range nuclear ALCMs, up to a total of 150 such heavy bombers, shall be attributed with ten warheads. Each heavy bomber equipped for long range nuclear ALCMs in excess of 150 such heavy bombers shall be attributed with a number of warheads equal to the number of long range nuclear ALCMs for which it is actually equipped. The United States of America shall specify the heavy bombers equipped for long range nuclear ALCMs that are in excess of 150 such heavy bombers by number, type, variant, and the air bases at which they are based. The number of long range nuclear ALCMs for which each heavy bomber equipped for long range nuclear ALCMs in excess of 150 such heavy bombers is considered to be actually equipped shall be the maximum number of long range nuclear ALCMs for which a heavy bomber of the same type and variant is actually equipped.

(F) For the Union of Soviet Socialist Republics, each heavy bomber equipped for long range nuclear ALCMs, up to a total of 180 such heavy bombers, shall be attributed with eight warheads. Each heavy bomber equipped for long range nuclear ALCMs in excess of 180 such heavy bombers shall be attributed with a number of warheads equal to the number of long range nuclear ALCMs for which it is actually equipped. The Union of Soviet Socialist Republics shall specify the heavy bombers equipped for long range nuclear ALCMs that are in excess of 180 such heavy bombers by number, type, variant, and the air bases at which they are based. The number of long range nuclear ALCMs for which each heavy bomber equipped for long range nuclear ALCMs in excess of 180 such heavy bombers is considered to be actually equipped shall be the maximum number of long range nuclear ALCMs for which a heavy bomber of the same type and variant is actually equipped.

(G) Each heavy bomber equipped for nuclear armaments other than long range nuclear ALCMs shall be attributed with one warhead. All heavy bombers not equipped for long range nuclear ALCMs shall be considered to be heavy bombers equipped for nuclear armaments other than long range nuclear ALCMs, with the exception of heavy bombers equipped for non-nuclear armaments, test heavy bombers, and training heavy bombers.

5. Each Party shall have the right to reduce the number of warheads attributed to ICBMs and SLBMs only of existing types, up to an aggregate number of 1,250 at any one time.

(A) Such aggregate number shall consist of the following:

(i) for the United States of America, the reduction in the number of warheads attributed to the type of ICBM designated by the United States of America as, and known to the Union of Soviet Socialist Republics as, Minuteman III, plus the reduction in the number of warheads attributed to ICBMs and SLBMs of no more than two other existing types;

(ii) for the Union of Soviet Socialist Republics, four multiplied by the number of deployed SLBMs designated by the Union of Soviet Socialist Republics as RSM-50, which is known to

the United States of America as SS-N-18, plus the reduction in the number of warheads attributed to ICBMs and SLBMs of no more than two other existing types.

(B) Reductions in the number of warheads attributed to Minuteman III ICBMs shall be carried out subject to the following:

(i) Minuteman III ICBMs to which different numbers of warheads are attributed shall not be deployed at the same ICBM base.

(ii) Any such reductions shall be carried out no later than seven years after entry into force of this Treaty.

(iii) The re-entry vehicle platform of each Minuteman III ICBM to which a reduced number of warheads is attributed shall be destroyed and replaced by a new re-entry vehicle platform.

(C) Reductions in the number of warheads attributed to ICBMs and SLBMs of types other than Minuteman III shall be carried out subject to the following:

(i) Such reductions shall not exceed 500 warheads at any one time for each Party.

(ii) After a Party has reduced the number of warheads attributed to ICBMs or SLBMs of two existing types, that Party shall not have the right to reduce the number of warheads attributed to ICBMs or SLBMs of any additional type.

(iii) The number of warheads attributed to an ICBM or SLBM shall be reduced by no more than four below the number attributed as of the date of signature of this Treaty.

(iv) ICBMs of the same type. but to which different numbers of warheads are attributed, shall not be deployed at the same ICBM base.

(v) SLBMs of the same type, but to which different numbers of warheads are attributed, shall not be deployed on submarines based at submarine bases adjacent the waters of the same ocean.

(vi) If the number of warheads attributed to an ICBM or SLBM of a particular type is reduced by more than two, the re-entry vehicle platform of each ICBM or SLBM to which such a reduced number of warheads is attributed shall be destroyed and replaced by a new re-entry vehicle platform.

(D) A Party shall not have the right to attribute to ICBMs of a new type a number of warheads greater than the smallest number of warheads attributed to any ICBM to which that Party has attributed a reduced number of warheads pursuant to subparagraph (C) of this paragraph. A Party shall not have the right to attribute to SLBMs of a new type a number of warheads greater than the smallest number of warheads attributed to any SLBM to which the Party has attributed a reduced number of warheads pursuant to subparagraph (C) of this paragraph.

6. Newly constructed strategic offensive arms shall begin to be subject to the limitations provided for in this Treaty as follows:

(A) an ICBM, when it first leaves a production facility;

(B) a mobile launcher of ICBMs, when it first leaves a production facility for mobile launchers of ICBMs;

(C) a silo launcher of ICBMs, when excavation for that launcher has been completed and the pouring of concrete for the silo has been completed, or 12 months after the excavation begins, whichever occurs earlier;

(D) for the purpose of counting a deployed ICBM and its associated launcher, a silo launcher of ICBMs shall be considered to contain a deployed ICBM when excavation for that launcher has been completed and the pouring of concrete for the silo has been completed, or 12 months after the excavation begins, whichever occurs earlier, and a mobile launcher of ICBMs shall be considered to contain a deployed ICBM when it arrives at a maintenance facility, except for the non-deployed mobile launchers of ICBMs provided for in subparagraph 2(B) of Article IV of this Treaty, or when it leaves an ICBM loading facility;

(E) an SLBM, when it first leaves a production facility;

(F) an SLBM launcher, when the submarine on which that launcher is installed is first launched;

(G) for the purpose of counting a deployed SLBM and its associated launcher, an SLBM launcher shall be considered to contain a deployed SLBM when the submarine on which that launcher is installed is first launched;

(H) a heavy bomber or former heavy bomber, when its airframe is first brought out of the shop, plant, or building in which components of a heavy bomber or former heavy bomber are assembled to produce complete airframes; or when its airframe is first brought out of the shop, plant, or building in which existing bomber airframes are converted to heavy bomber or former heavy bomber airframes.

7. ICBM launchers and SLBM launchers that have been converted to launch an ICBM or SLBM, respectively, of a different type shall not be capable of launching an ICBM or SLBM of the previous type. Such converted launchers shall be considered to be launchers of ICBMs or SLBMs of that different type as follows:

(A) a silo launcher of ICBMs, when an ICBM of a different type or a training model of a missile of a different type is first installed in that launcher, or when the silo door is reinstalled, whichever occurs first;

(B) a mobile launcher of ICBMs, as agreed within the framework of the Joint Compliance and Inspection Commission;

(C) an SLBM launcher, when all launchers on the submarine on which that launcher is installed have been converted to launch an SLBM of that different type and that submarine begins sea trials, that is, when that submarine first operates under its own power away from the harbor or port in which the conversion of launchers was performed.

8. Heavy bombers that have been converted into heavy bombers of a different category or into former heavy bombers shall be considered to be heavy bombers of that different category or former heavy bombers as follows:

(A) a heavy bomber equipped for nuclear armaments other than long range nuclear ALCMs converted into a heavy bomber equipped for long range nuclear ALCMs, when it is first brought out of the shop, plant, or building where it was equipped for long range nuclear ALCMs;

(B) a heavy bomber of one category converted into a heavy bomber of another category provided for in paragraph 9 of Section VI of the Protocol on Procedures Governing the Conversion or

Elimination of the Items Subject to this Treaty, hereinafter referred to as the Conversion or Elimination Protocol, or into a former heavy bomber, when the inspection conducted pursuant to paragraph 13 of Section VI of the Conversion or Elimination Protocol is completed or, if such an inspection is not conducted, when the 20-day period provided for in paragraph 13 of Section VI of the Conversion or Elimination Protocol expires.

9. For the purposes of this Treaty:

(A) A ballistic missile of a type developed and tested solely to intercept and counter objects not located on the surface of the Earth shall not be considered to be a ballistic missile to which the limitations provided for in this Treaty apply.

(B) If a ballistic missile has been flight-tested or deployed for weapon delivery, all ballistic missiles of that type shall be considered to be weapon-delivery vehicles.

(C) If a cruise missile has been flight-tested or deployed for weapon delivery, all cruise missiles of that type shall be considered to be weapon-delivery vehicles.

(D) If a launcher, other than a soft-site launcher, has contained an ICBM or SLBM of a particular type, it shall be considered to be a launcher of ICBMs or SLBMs of that type. If a launcher, other than a soft-site launcher, has been converted into a launcher of ICBMs or SLBMs of a different type, it shall be considered to be a launcher of ICBMs or SLBMs of the type for which it has been converted.

(E) If a heavy bomber is equipped for long range nuclear ALCMs, all heavy bombers of that type shall be considered to be equipped for long range nuclear ALCMs, except those that are not so equipped and are distinguishable from heavy bombers of the same type equipped for long range nuclear ALCMs. If long range nuclear ALCMs have not been flight-tested from any heavy bomber of a particular type, no heavy bomber of that type shall be considered to be equipped for long range nuclear ALCMs. Within the same type, a heavy bomber equipped for long range nuclear ALCMs, a heavy bomber equipped for nuclear armaments other than long range nuclear ALCMs, a heavy bomber equipped for non-nuclear armaments, a training heavy bomber, and a former heavy bomber shall be distinguishable from one another.

(F) Any long range ALCM of a type, any one of which has been initially flight-tested from a heavy bomber on or before December 31, 1988, shall be considered to be a long range nuclear ALCM. Any long range ALCM of a type, any one of which has been initially flight-tested from a heavy bomber after December 31, 1988, shall not be considered to be a long range nuclear ALCM if it is a long range non-nuclear ALCM and is distinguishable from long range nuclear ALCMs. Long range non-nuclear ALCMs not so distinguishable shall be considered to be long range nuclear ALCMs.

(G) Mobile launchers of ICBMs of each new type of ICBM shall be distinguishable from mobile launchers of ICBMs of existing types of ICBMs and from mobile launchers of ICBMs of other new types of ICBMs. Such new launchers, with their associated missiles installed, shall be distinguishable from mobile launchers of ICBMs of existing types of ICBMs with their associated missiles installed, and from mobile launchers of ICBMs of other new types of ICBMs with their associated missiles installed.

(H) Mobile launchers of ICBMs converted into launchers of ICBMs of another type of ICBM shall be distinguishable from mobile launchers of ICBMs of the previous type of ICBM. Such converted launchers, with their associated missiles installed, shall be distinguishable from mobile launchers of ICBMs of the previous type of ICBM with their associated missiles installed. Conversion of mobile launchers of ICBMs shall be carried out in accordance with procedures to be agreed within the framework of the Joint Compliance and Inspection Commission.

10. As of the date of signature of this Treaty:

(A) Existing types of ICBMs and SLBMs are:

(i) for the United States of America, the types of missiles designated by the United States of America as Minuteman II, Minuteman III, Peacekeeper, Poseidon, Trident I, and Trident II, which are known to the Union of Soviet Socialist Republics as Minuteman II, Minuteman III, MX, Poseidon, Trident I, and Trident II, respectively;

(ii) for the Union of Soviet Socialist Republics, the types of missiles designated by the Union of Soviet Socialist Republics as RS-10, RS-12, RS-16, RS-20, RS-18, RS-22, RS-12M, RSM-25, RSM-40, RSM-50, RSM-52, and RSM-54, which are known to the United States of America as SS-11, SS-13, SS-17, SS-18, SS-19, SS-24, SS-25, SS-N-6, SS-N-8, SS-N-18, SS-N-20, and SS-N-23, respectively.

(B) Existing types of ICBMs for mobile launchers of ICBMs are:

(i) for the United States of America, the type of missile designated by the United States of America as Peacekeeper, which is known to the Union of Soviet Socialist Republics as MX;

(ii) for the Union of Soviet Socialist Republics, the types of missiles designated by the Union of Soviet Socialist Republics as RS-22 and RS-12M, which are known to the United States of America as SS-24 and SS-25, respectively.

(C) Former types of ICBMs and SLBMs are the types of missiles designated by the United States of America as, and known to the Union of Soviet Socialist Republics as, Minuteman I and Polaris A-3.

(D) Existing types of heavy bombers are:

(i) for the United States of America, the types of bombers designated by the United States of America as, and known to the Union of Soviet Socialist Republics as, B-52, B-1, and B-2;

(ii) for the Union of Soviet Socialist Republics, the types of bombers designated by the Union of Soviet Socialist Republics as Tu-95 and Tu-160, which are known to the United States of America as Bear and Blackjack, respectively.

(E) Existing types of long range nuclear ALCMs are:

(i) for the United States of America, the types of long range nuclear ALCMs designated by the United States of America as, and known to the Union of Soviet Socialist Republics as, AGM-86B and AGM-129;

(ii) for the Union of Soviet Socialist Republics, the types of long range nuclear ALCMs designated by the Union of Soviet Socialist Republics as RKV-500A and RKV-500B, which are known to the United States of America as AS-15 A and AS-15 B, respectively.

Article IV

1. For ICBMs and SLBMs:
(A) Each Party shall limit the aggregate number of non-deployed ICBMs for mobile launchers of ICBMs to no more than 250. Within this limit, the number of non-deployed ICBMs for rail-mobile launchers of ICBMs shall not exceed 125.
(B) Each Party shall limit the number of non-deployed ICBMs at a maintenance facility of an ICBM base for mobile launchers of ICBMs to no more than two ICBMs of each type specified for that ICBM base. Non-deployed ICBMs for mobile launchers of ICBMs located at a maintenance facility shall be stored separately from non-deployed mobile launchers of ICBMs located at that maintenance facility.
(C) Each Party shall limit the number of non-deployed ICBMs and sets of ICBM emplacement equipment at an ICBM base for silo launchers of ICBMs to no more than:
(i) two ICBMs of each type specified for that ICBM base and six sets of ICBM emplacement equipment for each type of ICBM specified for that ICBM base; or
(ii) four ICBMs of each type specified for that ICBM base and two sets of ICBM emplacement equipment for each type of ICBM specified for that ICBM base.
(D) Each Party shall limit the aggregate number of ICBMs and SLBMs located at test ranges to no more than 35 during the seven-year period after entry into force of this Treaty. Thereafter, the aggregate number of ICBMs and SLBMs located at test ranges shall not exceed 25.
2. For ICBM launchers and SLBM launchers:
(A) Each Party shall limit the aggregate number of non-deployed mobile launchers of ICBMs to no more than 110. Within this limit, the number of non-deployed rail-mobile launchers of ICBMs shall not exceed 18.
(B) Each Party shall limit the number of non-deployed mobile launchers of ICBMs located at the maintenance facility of each ICBM base for mobile launchers of ICBMs to no more than two such ICBM launchers of each type of ICBM specified for that ICBM base.
(C) Each Party shall limit the number of non-deployed mobile launchers of ICBMs located at training facilities for ICBMs to no more than 40. Each such launcher may contain only a training model of a missile. Non-deployed mobile launchers of ICBMs that contain training models of missiles shall not be located outside a training facility.
(D) Each Party shall limit the aggregate number of test launchers to no more than 45 during the seven-year period after entry into force of this Treaty. Within this limit, the number of fixed test launchers shall not exceed 25, and the number of mobile test launchers shall not exceed 20. Thereafter, the aggregate number of test launchers shall not exceed 40. Within this limit, the number of fixed test launchers shall not exceed 20, and the number of mobile test launchers shall not exceed 20.
(E) Each Party shall limit the aggregate number of silo training launchers and mobile training launchers to no more than 60. ICBMs shall not be launched from training launchers. Each such launcher may contain only a training model of a missile. Mobile training launchers shall not be capable of launching ICBMs, and shall differ from mobile launchers of ICBMs and other road vehicles or railcars on the basis of differences that are observable by national technical means of verification.
3. For heavy bombers and former heavy bombers:
(A) Each Party shall limit the aggregate number of heavy bombers equipped for non-nuclear armaments, former heavy bombers, and training heavy bombers to no more than 75.
(B) Each Party shall limit the number of test heavy bombers to no more than 20.
4. For ICBMs and SLBMs used for delivering objects into the upper atmosphere or space:
(A) Each Party shall limit the number of space launch facilities to no more than five, unless otherwise agreed. Space launch facilities shall not overlap ICBM bases.
(B) Each Party shall limit the aggregate number of ICBM launchers and SLBM launchers located at space launch facilities to no more than 20, unless otherwise agreed. Within this limit, the aggregate number of silo launchers of ICBMs and mobile launchers of ICBMs located at space launch facilities shall not exceed ten, unless otherwise agreed.
(C) Each Party shall limit the aggregate number of ICBMs and SLBMs located at a space launch facility to no more than the number of ICBM launchers and SLBM launchers located at that facility.
5. Each Party shall limit the number of transporter-loaders for ICBMs for road mobile launchers of ICBMs located at each deployment area or test range to no more than two for each type of ICBM for road mobile launchers of ICBMs that is attributed with one warhead and that is specified for that deployment area or test range, and shall limit the number of such transporter-loaders located outside deployment areas and test ranges to no more than six. The aggregate number of transporter-loaders for ICBMs for road mobile launchers of ICBMs shall not exceed 30.
6. Each Party shall limit the number of ballistic missile submarines in dry dock within five kilometers of the boundary of each submarine base to no more than two.
7. For static displays and ground trainers:
(A) Each Party shall limit the number of ICBM launchers and SLBM launchers placed on static display after signature of this Treaty to no more than 20, the number of ICBMs and SLBMs placed on static display after signature of this Treaty to no more than 20, the number of launch canisters placed on static display after signature of this Treaty to no more than 20, and the number of heavy bombers and former heavy bombers placed on static display after signature of this Treaty to no more than 20. Such items placed on static display prior to signature of this Treaty shall be specified in Annex I to the Memorandum of Understanding, but shall not be subject to the limitations provided for in this Treaty.
(B) Each Party shall limit the aggregate number of heavy bombers converted after signature of this Treaty for use as ground trainers and former heavy bombers converted after signature of this Treaty for use as ground trainers to no more than five. Such items converted prior to signature of this Treaty for use as ground trainers shall be specified in Annex I to the Memorandum of Understanding, but shall not be subject to the limitations provided for in this Treaty.
8. Each Party shall limit the aggregate number of storage facilities for ICBMs or SLBMs and repair facilities for ICBMs or SLBMs to no more than 50.

9. With respect to locational and related restrictions on strategic offensive arms:

(A) Each Party shall locate non-deployed ICBMs and non-deployed SLBMs only at maintenance facilities of ICBM bases; submarine bases; ICBM loading facilities; SLBM loading facilities; production facilities for ICBMs or SLBMs; repair facilities for ICBMs or SLBMs; storage facilities for ICBMs or SLBMs; conversion or elimination facilities for ICBMs or SLBMs; test ranges; or space launch facilities. Prototype ICBMs and prototype SLBMs, however, shall not be located at maintenance facilities of ICBM bases or at submarine bases. Non-deployed ICBMs and non-deployed SLBMs may also be in transit. Non-deployed ICBMs for silo launchers of ICBMs may also be transferred within an ICBM base for silo launchers of ICBMs. Non-deployed SLBMs that are located on missile tenders and storage cranes shall be considered to be located at the submarine base at which such missile tenders and storage cranes are specified as based.

(B) Each Party shall locate non-deployed mobile launchers of ICBMs only at maintenance facilities of ICBM bases for mobile launchers of ICBMs, production facilities for mobile launchers of ICBMs, repair facilities for mobile launchers of ICBMs, storage facilities for mobile launchers of ICBMs, ICBM loading facilities, training facilities for ICBMs, conversion or elimination facilities for mobile launchers of ICBMs, test ranges, or space launch facilities. Mobile launchers of prototype ICBMs, however, shall not be located at maintenance facilities of ICBM bases for mobile launchers of ICBMs. Non-deployed mobile launchers of ICBMs may also be in transit.

(C) Each Party shall locate test launchers only at test ranges, except that rail-mobile test launchers may conduct movements for the purpose of testing outside a test range, provided that:

(i) each such movement is completed no later than 30 days after it begins;

(ii) each such movement begins and ends at the same test range and does not involve movement to any other facility;

(iii) movements of no more than six rail-mobile launchers of ICBMs are conducted in each calendar year; and

(iv) no more than one train containing no more than three rail-mobile test launchers is located outside test ranges at any one time.

(D) A deployed mobile launcher of ICBMs and its associated missile that relocates to a test range may, at the discretion of the testing Party, either continue to be counted toward the maximum aggregate limits provided for in Article II of this Treaty, or be counted as a mobile test launcher pursuant to paragraph 2(D) of this Article. If a deployed mobile launcher of ICBMs and its associated missile that relocates to a test range continues to be counted toward the maximum aggregate limits provided for in Article II of this Treaty, the period of time during which it continuously remains at a test range shall not exceed 45 days. The number of such deployed road mobile launchers of ICBMs and their associated missiles located at a test range at any one time shall not exceed three, and the number of such deployed rail-mobile launchers of ICBMs and their associated missiles located at a test range at any one time shall not exceed three.

(E) Each Party shall locate silo training launchers only at ICBM bases for silo launchers of ICBMs and training facilities for ICBMs. The number of silo training launchers located at each ICBM base for silo launchers of ICBMs shall not exceed one for each type of ICBM specified for the ICBM base.

(F) Test heavy bombers shall be based only at heavy bomber flight test centers and at production facilities for heavy bombers. Training heavy bombers shall be based only at training facilities for heavy bombers.

10. Each Party shall locate solid rocket motors for first stages of ICBMs for mobile launchers of ICBMs only at locations where production and storage, or testing of such motors occurs and at production facilities for ICBMs for mobile launchers of ICBMs. Such solid rocket motors may also be moved between these locations. Solid rocket motors with nozzles attached for the first stages of ICBMs for mobile launchers of ICBMs shall only be located at production facilities for ICBMs for mobile launchers of ICBMs and at locations where testing of such solid rocket motors occurs. Locations where such solid rocket motors are permitted shall be specified in Annex I to the Memorandum of Understanding.

11. With respect to locational restrictions on facilities:

(A) Each Party shall locate production facilities for ICBMs of a particular type, repair facilities for ICBMs of a particular type, storage facilities for ICBMs of a particular type, ICBM loading facilities for ICBMs of a particular type, and conversion or elimination facilities for ICBMs of a particular type no less than 100 kilometers from any ICBM base for silo launchers of ICBMs of that type of ICBM, any ICBM base for rail-mobile launchers of ICBMs of that type of ICBM, any deployment area for road mobile launchers of ICBMs of that type of ICBM, any test range from which ICBMs of that type are flight-tested, any production facility for mobile launchers of ICBMs of that type of ICBM, any repair facility for mobile launchers of ICBMs of that type of ICBM, any storage facility for mobile launchers of ICBMs of that type of ICBM, and any training facility for ICBMs at which non-deployed mobile launchers of ICBMs are located. New facilities at which non-deployed ICBMs for silo launchers of ICBMs of any type of ICBM may be located, and new storage facilities for ICBM emplacement equipment, shall be located no less than 100 kilometers from any ICBM base for silo launchers of ICBMs, except that existing storage facilities for intermediate range missiles, located less than 100 kilometers from an ICBM base for silo launchers of ICBMs or from a test range, may be converted into storage facilities for ICBMs not specified for that ICBM base or that test range.

(B) Each Party shall locate production facilities for mobile launchers of ICBMs of a particular type of ICBM, repair facilities for mobile launchers of ICBMs of a particular type of ICBM, and storage facilities for mobile launchers of ICBMs of a particular type of ICBM no less that 100 kilometers from any ICBM base for mobile launchers of ICBMs of that type of ICBM and any test range from which ICBMs of that type are flight-tested.

(C) Each Party shall locate test ranges and space launch facilities no less than 100 kilometers from any ICBM base for silo launchers of ICBMs, any ICBM base for rail-mobile launchers of ICBMs, and any deployment area.

(D) Each Party shall locate training facilities for ICBMs no less than 100 kilometers from any test range.

(E) Each Party shall locate storage areas for heavy bomber nuclear armaments no less than 100 kilometers from any air base for heavy bombers equipped for non-nuclear armaments and any

training facility for heavy bombers. Each Party shall locate storage areas for long range nuclear ALCMs no less than 100 kilometers from any air base for heavy bombers equipped for nuclear armaments other than long range nuclear ALCMs, any air base for heavy bombers equipped for non-nuclear armaments, and any training facility for heavy bombers.

12. Each Party shall limit the duration of each transit to no more than 30 days.

Article V

1. Except as prohibited by the provisions of this Treaty, modernization and replacement of strategic offensive arms may be carried out.
2. Each Party undertakes not to:
   (A) produce, flight-test, or deploy heavy ICBMs of a new type, or increase the launch weight or throw-weight of heavy ICBMs of an existing type;
   (B) produce, flight-test, or deploy heavy SLBMs;
   (C) produce, test, or deploy mobile launchers of heavy ICBMs;
   (D) produce, test, or deploy additional silo launchers of heavy ICBMs, except for silo launchers of heavy ICBMs that replace silo launchers of heavy ICBMs that have been eliminated in accordance with Section II of the Conversion or Elimination Protocol, provided that the limits provided for in Article II of this Treaty are not exceeded;
   (E) convert launchers that are not launchers of heavy ICBMs into launchers of heavy ICBMs;
   (F) produce, test, or deploy launchers of heavy SLBMs;
   (G) reduce the number of warheads attributed to a heavy ICBM of an existing type.
3. Each Party undertakes not to deploy ICBMs other than in silo launchers of ICBMs, on road mobile launchers of ICBMs, or on rail-mobile launchers of ICBMs. Each Party undertakes not to produce, test, or deploy ICBM launchers other than silo launchers of ICBMs, road mobile launchers of ICBMs, or rail-mobile launchers of ICBMs.
4. Each Party undertakes not to deploy on a mobile launcher of ICBMs an ICBM of a type that was not specified as a type of ICBM for mobile launchers of ICBMs in accordance with paragraph 2 of Section VII of the Protocol on Notifications Relating to this Treaty, hereinafter referred to as the Notification Protocol, unless it is an ICBM to which no more than one warhead is attributed and the Parties have agreed within the framework of the Joint Compliance and Inspection Commission to permit deployment of such ICBMs on mobile launchers of ICBMs. A new type of ICBM for mobile launchers of ICBMs may cease to be considered to be a type of ICBM for mobile launchers of ICBMs if no ICBM of that type has been contained on, or flight-tested from, a mobile launcher of ICBMs.
5. Each Party undertakes not to deploy ICBM launchers of a new type of ICBM and not to deploy SLBM launchers of a new type of SLBM if such launchers are capable of launching ICBMs or SLBMs, respectively, of other types. ICBM launchers of existing types of ICBMs and SLBM launchers of existing types of SLBMs shall be incapable, without conversion, of launching ICBMs or SLBMs, respectively, of other types.
6. Each Party undertakes not to convert SLBMs into ICBMs for mobile launchers of ICBMs, or to load SLBMs on, or launch SLBMs from, mobile launchers of ICBMs.
7. Each Party undertakes not to produce, test, or deploy transporter-loaders other than transporter-loaders for ICBMs for road mobile launchers of ICBMs attributed with one warhead.
8. Each Party undertakes not to locate deployed silo launchers of ICBMs outside ICBM bases for silo launchers of ICBMs.
9. Each Party undertakes not to locate soft-site launchers except at test ranges and space launch facilities. All existing soft-site launchers not at test ranges or space launch facilities shall be eliminated in accordance with the procedures provided for in the Conversion or Elimination Protocol no later than 60 days after entry into force of this Treaty.
10. Each Party undertakes not to:
   (A) flight-test ICBMs or SLBMs of a retired or former type from other than test launchers specified for such use or launchers at space launch facilities. Except for soft-site launchers, test launchers specified for such use shall not be used to flight-test ICBMs or SLBMs of a type, any one of which is deployed;
   (B) produce ICBMs for mobile launchers of ICBMs of a retired type.
11. Each Party undertakes not to convert silos used as launch control centers into silo launchers of ICBMs.
12. Each Party undertakes not to:
   (A) produce, flight-test, or deploy an ICBM or SLBM with more than ten re-entry vehicles;
   (B) flight-test an ICBM or SLBM with a number of re-entry vehicles greater than the number of warheads attributed to it, or, for an ICBM or SLBM of a retired type, with a number of re-entry vehicles greater than the largest number of warheads that was attributed to any ICBM or SLBM of that type;
   (C) deploy an ICBM or SLBM with a number of re-entry vehicles greater than the number of warheads attributed to it;
   (D) increase the number of warheads attributed to an ICBM or SLBM of an existing or new type.
13. Each Party undertakes not to flight-test or deploy an ICBM or SLBM with a number of re-entry vehicles greater than the number of warheads attributed to it.
14. Each Party undertakes not to flight-test from space launch facilities ICBMs or SLBMs equipped with re-entry vehicles.
15. Each Party undertakes not to use ICBMs or SLBMs for delivering objects into the upper atmosphere or space for purposes inconsistent with existing international obligations undertaken by the Parties.
16. Each Party undertakes not to produce, test, or deploy systems for rapid reload and not to conduct rapid reload.
17. Each Party undertakes not to install SLBM launchers on submarines that were not originally constructed as ballistic missile submarines.
18. Each Party undertakes not to produce, test, or deploy:

(A) ballistic missiles with a range in excess of 600 kilometers, or launchers of such missiles, for installation on waterborne vehicles, including free-floating launchers, other than submarines. This obligation shall not require changes in current ballistic missile storage, transport, loading, or unloading practices;

(B) launchers of ballistic or cruise missiles for emplacement on or for tethering to the ocean floor, the seabed, or the beds of internal waters and inland waters, or for emplacement in or for tethering to the subsoil thereof, or mobile launchers of such missiles that move only in contact with the ocean floor, the seabed, or the beds of internal waters and inland waters, or missiles for such launchers. This obligation shall apply to all areas of the ocean floor and the seabed, including the seabed zone referred to in Articles I and II of the Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Seabed and the Ocean Floor and in the Subsoil Thereof of February 11, 1971;

(C) systems, including missiles, for placing nuclear weapons or any other kinds of weapons of mass destruction into Earth orbit or a fraction of an Earth orbit;

(D) Air-to-Surface Ballistic Missiles (ASBMs);

(E) long range nuclear ALCMs armed with two or more nuclear weapons.

19. Each Party undertakes not to:

(A) flight-test with nuclear armaments an aircraft that is not an airplane, but that has a range of 8,000 kilometers or more; equip such an aircraft for nuclear armaments; or deploy such an aircraft with nuclear armaments;

(B) flight-test with nuclear armaments an airplane that was not initially constructed as a bomber, but that has a range of 8,000 kilometers or more, or an integrated platform area in excess of 310 square meters; equip such an airplane for nuclear armaments; or deploy such an airplane with nuclear armaments;

(C) flight-test with long range nuclear ALCMs an aircraft that is not an airplane, or an airplane that was not initially constructed as a bomber; equip such as aircraft or such an airplane for long range nuclear ALCMs; or deploy such an aircraft or such an airplane with long range nuclear ALCMs.

20. The United States of America undertakes not to equip existing or future heavy bombers for more than 20 long range nuclear ALCMs.

21. The Union of Soviet Socialist Republics undertakes not to equip existing or future heavy bombers for more than 16 long range nuclear ALCMs.

22. Each Party undertakes not to locate long range nuclear ALCMs at air bases for heavy bombers equipped for nuclear armaments other than long range nuclear ALCMs, air bases for heavy bombers equipped for non-nuclear armaments, air bases for former heavy bombers, or training facilities for heavy bombers.

23. Each Party undertakes not to base heavy bombers equipped for long range nuclear ALCMs, heavy bombers equipped for nuclear armaments other than long range nuclear ALCMs, or heavy bombers equipped for non-nuclear armaments at air bases at which heavy bombers of either of the other two categories are based.

24. Each Party undertakes not to convert:

(A) heavy bombers equipped for nuclear armaments other than long range nuclear ALCMs into heavy bombers equipped for long range nuclear ALCMs, if such heavy bombers were previously equipped for long range nuclear ALCMs;

(B) heavy bombers equipped for non-nuclear armaments into heavy bombers equipped for long range nuclear ALCMs or into heavy bombers equipped for nuclear armaments other than long range nuclear ALCMs;

(C) training heavy bombers into heavy bombers of another category;

(D) former heavy bombers into heavy bombers.

25. Each Party undertakes not to have underground facilities accessible to ballistic missile submarines.

26. Each Party undertakes not to locate railcars at the site of a rail garrison that has been eliminated in accordance with Section IX of the Conversion or Elimination Protocol, unless such railcars have differences, observable by national technical means of verification, in length, width, or height from rail-mobile launchers of ICBMs or launch-associated railcars.

27. Each Party undertakes not to engage in any activities associated with strategic offensive arms at eliminated facilities, notification of the elimination of which has been provided in accordance with paragraph 3 of Section I of the Notification Protocol, unless notification of a new facility at the same location has been provided in accordance with paragraph 3 of Section I of the Notification Protocol. Strategic offensive arms and support equipment shall not be located at eliminated facilities except during their movement through such facilities and during visits of heavy bombers or former heavy bombers at such facilities. Missile tenders may be located at eliminated facilities only for purposes not associated with strategic offensive arms.

28. Each Party undertakes not to base strategic offensive arms subject to the limitations of this Treaty outside its national territory.

29. Each Party undertakes not to use naval vessels that were formerly declared as missile tenders to transport, store, or load SLBMs. Such naval vessels shall not be tied to a ballistic missile submarine for the purpose of supporting such a submarine if such a submarine is located within five kilometers of a submarine base.

30. Each Party undertakes not to remove from production facilities for ICBMs for mobile launchers of ICBMs, solid rocket motors with attached nozzles for the first stages of ICBMs for mobile launchers of ICBMs except for:

(A) the removal of such motors as part of assembled first stages of ICBMs for mobile launchers of ICBMs that are maintained, stored, and transported in stages;

(B) the removal of such motors as part of assembled ICBMs for mobile launchers of ICBMs that are maintained, stored, and transported as assembled missiles in launch canisters or without launch canisters; and

(C) the removal of such motors as part of assembled first stages of ICBMs for mobile launchers of ICBMs that are maintained, stored, and transported as assembled missiles in launch canisters or without launch canisters, for the purpose of technical characteristics exhibitions.

Article VI

1. Deployed road mobile launchers of ICBMs and their associated missiles shall be based only in restricted areas. A restricted area shall not exceed five square kilometers in size and shall not overlap another restricted area. No more than ten deployed road mobile launchers of ICBMs and their associated missiles may be based or located in a restricted area. A restricted area shall not contain deployed ICBMs for road mobile launchers of ICBMs of more than one type of ICBM.
2. Each Party shall limit the number of fixed structures for road mobile launchers of ICBMs within each restricted area so that these structures shall not be capable of containing more road mobile launchers of ICBMs than the number of road mobile launchers of ICBMs specified for that restricted area.
3. Each restricted area shall be located within a deployment area. A deployment area shall not exeed 125,000 square kilometers in size and shall not overlap another deployment area. A deployment area shall contain no more than one ICBM base for road mobile launchers of ICBMs.
4. Deployed rail-mobile launchers of ICBMs and their associated missiles shall be based only in rail garrisons. Each Party shall have no more than seven rail garrisons. No point on a portion of track located inside a rail garrison shall be more than 20 kilometers from any entrance/exit for that rail garrison. This distance shall be measured along the tracks. A rail garrison shall not overlap another rail garrison.
5. Each rail garrison shall have no more than two rail entrances/exits. Each such entrance/exit shall have no more than two separate sets of tracks passing through it (a total of four rails).
6. Each Party shall limit the number of parking sites in each rail garrison to no more than the number of trains of standard configuration specified for that rail garrison. Each rail garrison shall have no more than five parking sites.
7. Each Party shall limit the number of fixed structures for rail-mobile launchers of ICBMs in each rail garrison to no more than the number of trains of standard configuration specified for that rail garrison. Each such structure shall contain no more than one train of standard configuration.
8. Each rail garrison shall contain no more than one maintenance facility.
9. Deployed mobile launchers of ICBMs and their associated missiles may leave restricted areas or rail garrisons only for routine movements, relocations, or dispersals. Deployed road mobile launchers of ICBMs and their associated missiles may leave deployment areas only for relocations or operational dispersals.
10. Relocations shall be completed within 25 days. No more than 15 per cent of the total number of deployed road mobile launchers of ICBMs and their associated missiles or five such launchers and their associated missiles, whichever is greater, may be outside restricted areas at any one time for the purpose of relocation. No more than 20 per cent of the total number of deployed rail-mobile launchers of ICBMs and their associated missiles or five such launchers and their associated missiles, whichever is greater, may be outside rail garrisons at any one time for the purpose of relocation.
11. No more than 50 per cent of the total number of deployed rail-mobile launchers of ICBMs and their associated missiles may be engaged in routine movements at any one time.
12. All trains with deployed rail-mobile launchers of ICBMs and their associated missiles of a particular type shall be of one standard configuration. All such trains shall conform to that standard configuration except those taking part in routine movements, relocations, or dispersals, and except that portion of a train remaining within a rail garrison after the other portion of such a train has departed for the maintenance facility associated with that rail garrison, has been relocated to another facility, or has departed the rail garrison for routine movement. Except for dispersals, notification of variations from standard configuration shall be provided in accordance with paragraphs 13, 14, and 15 of Section II of the Notification Protocol.

Article VII

1. Conversion and elimination of strategic offensive arms, fixed structures for mobile launchers of ICBMs, and facilities shall be carried out pursuant to this Article and in accordance with procedures provided for in the Conversion or Elimination Protocol. Conversion and elimination shall be verified by national technical means of verification and by inspection as provided for in Articles IX and XI of this Treaty; in the Conversion or Elimination Protocol; and in the Protocol on Inspections and Continuous Monitoring Activities Relating to this Treaty, hereinafter referred to as the Inspection Protocol.
2. ICBMs for mobile launchers of ICBMs, ICBM launchers, SLBM launchers, heavy bombers, former heavy bombers, and support equipment shall be subject to the limitations provided for in this Treaty until they have been eliminated, or otherwise cease to be subject to the limitations provided for in this Treaty, in accordance with procedures provided for in the Conversion or Elimination Protocol.
3. ICBMs for silo launchers of ICBMs and SLBMs shall be subject to the limitations provided for in this Treaty until they have been eliminated by rendering them inoperable, precluding their use for their original purpose, using procedures at the discretion of the Party possessing the ICBMs or SLBMs.
4. The elimination of ICBMs for mobile launchers of ICBMs, mobile launchers of ICBMs, SLBM launchers, heavy bombers, and former heavy bombers shall be carried out at conversion or elimination facilities, except as provided for in Sections VII and VIII of the Conversion or Elimination Protocol. Fixed launchers of ICBMs and fixed structures for mobile launchers of ICBMs subject to elimination shall be eliminated *in situ*. A launch canister remaining at a test range or ICBM base after the flight test of an ICBM for mobile launchers of ICBMs shall be eliminated in the open in situ, or at a conversion or elimination facility, in accordance with procedures provided for in the Conversion or Elimination Protocol.

Article VIII

1. A data base pertaining to the obligations under this Treaty is set forth in the Memorandum of Understanding, in which data with respect to items subject to the limitations provided for in this Treaty are listed according to categories of data.
2. In order to ensure the fulfillment of its obligations with respect to this Treaty, each Party shall notify the other Party of changes in data, as provided for in subparagraph 3(A) of this Article, and shall also

provide other notifications required by paragraph 3 of this Article, in accordance with the procedures provided for in paragraphs 4, 5, and 6 of this Article, the Notification Protocol, and the Inspection Protocol.

3. Each Party shall provide to the other Party, in accordance with the Notification Protocol, and, for subparagraph (i) of this paragraph, in accordance with Section III of the Inspection Protocol:

(A) notifications concerning data with respect to items subject to the limitations provided for in this Treaty, according to categories of data contained in the Memorandum of Understanding and other agreed categories of data;

(B) notifications concerning movement of items subject to the limitations provided for in this Treaty;

(C) notifications concerning data on ICBM and SLBM throw-weight in connection with the Protocol on ICBM and SLBM Throw-weight Relating to this Treaty, hereinafter referred to as the Throw-weight Protocol;

(D) notifications concerning conversion or elimination of items subject to the limitations provided for in this Treaty or elimination of facilities subject to this Treaty;

(E) notifications concerning cooperative measures to enhance the effectiveness of national technical means of verification;

(F) notifications concerning flight tests of ICBMs or SLBMs and notifications concerning telemetric information;

(G) notifications concerning strategic offensive arms of new types and new kinds;

(H) notifications concerning changes in the content of information provided pursuant to this paragraph, including the rescheduling of activities;

(I) notifications concerning inspections and continuous monitoring activities; and

(J) notifications concerning operational dispersals.

4. Each Party shall use the Nuclear Risk Reduction Centers, which provide for continuous communication between the Parties, to provide and receive notifications in accordance with the Notification Protocol and the Inspection Protocol, unless otherwise provided for in this Treaty, and to acknowledge receipt of such notifications no later than one hour after receipt.

5. If a time is to be specified in a notification provided pursuant to this Article, that time shall be expressed in Greenwich Mean Time. If only a date is to be specified in a notification, that date shall be specified as the 24 hour period that corresponds to the date in local time, expressed in Greenwich Mean Time.

6. Except as otherwise provided in this Article, each Party shall have the right to release to the public all data current as of September 1, 1990, that are listed in the Memorandum of Understanding, as well as the photographs that are appended thereto. Geographic coordinates and site diagrams that are received pursuant to the Agreement Between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on Exchange of Geographic Coordinates and Site Diagrams Relating to the Treaty of July 31, 1991, shall not be released to the public unless otherwise agreed. The Parties shall hold consultations on releasing to the public data and other information provided pursuant to this Article or received otherwise in fulfilling the obligations provided for in this Treaty. The provisions of this Article shall not affect the rights and obligations of the Parties with respect to the communication of such data and other information to those individuals who, because of their official responsibilities, require such data or other information to carry out activities related to the fulfillment of the obligations provided for in this Treaty.

Article IX

1. For the purpose of ensuring verification of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law.

2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1 of this Article.

3. Each Party undertakes not to use concealment measures that impede verification, by national technical means of verification, of compliance with the provisions of this Treaty. In this connection, the obligation not to use concealment measures includes the obligation not to use them at test ranges, including measures that result in the concealment of ICBMs, SLBMs, mobile launchers of ICBMs, or the association between ICBMs or SLBMs and their launchers during testing. The obligation not to use concealment measures shall not apply to cover or concealment practices at ICBM bases and deployment areas, or to the use of environmental shelters for strategic offensive arms.

4. To aid verification, each ICBM for mobile launchers of ICBMs shall have a unique identifier as provided for in the Inspection Protocol.

Article X

1. During each flight test of an ICBM or SLBM, the Party conducting the flight test shall make on-board technical measurements and shall broadcast all telemetric information obtained from such measurements. The Party conducting the flight test shall determine which technical parameters are to be measured during such flight test, as well as the methods of processing and transmitting telemetric information.

2. During each flight test of an ICBM or SLBM, the Party conducting the flight test undertakes not to engage in any activity that denies full access to telemetric information, including:

(A) the use of encryption;

(B) the use of jamming;

(C) broadcasting telemetric information from an ICBM or SLBM using narrow directional beaming; and

(D) encapsulation of telemetric information, including the use of ejectable capsules or recoverable re-entry vehicles.

3. During each flight test of an ICBM or SLBM, the Party conducting the flight test undertakes not to broadcast from a re-entry vehicle telemetric information that pertains to the functioning of the stages or the self-contained dispensing mechanism of the ICBM or SLBM.
4. After each flight test of an ICBM or SLBM, the Party conducting the flight test shall provide, in accordance with Section I of the Protocol on Telemetric Information Relating to the Treaty, hereinafter referred to as the Telemetry Protocol, tapes that contain a recording of all telemetric information that is broadcast during the flight test.
5. After each flight test of an ICBM or SLBM, the Party conducting the flight test shall provide, in accordance with Section II of the Telemetry Protocol, data associated with the analysis of the telemetric information.
6. Notwithstanding the provisions of paragraphs 1 and 2 of this Article, each Party shall have the right to encapsulate and encrypt on-board technical measurements during no more than a total of eleven flight tests of ICBMs or SLBMs each year. Of these eleven flight tests each year, no more than four shall be flight tests of ICBMs or SLBMs of each type, any missile of which has been flight-tested with a self-contained dispensing mechanism. Such encapsulation shall be carried out in accordance with Section I and paragraph 1 of Section III of the Telemetry Protocol, and such encryption shall be carried out in accordance with paragraph 2 of Section III of the Telemetry Protocol. Encapsulation and encryption that are carried out on the same flight test of an ICBM or SLBM shall count as two flight tests against the quotas specified in this paragraph.

Article XI

1. For the purpose of ensuring verification of compliance with the provisions of this Treaty, each Party shall have the right to conduct inspections and continuous monitoring activities and shall conduct exhibitions pursuant to this Article and the Inspection Protocol. Inspections, continuous monitoring activities, and exhibitions shall be conducted in accordance with the procedures provided for in the Inspection Protocol and the Conversion or Elimination Protocol.
2. Each Party shall have the right to conduct baseline data inspections at facilities to confirm the accuracy of data on the numbers and types of items specified for such facilities in the initial exchange of data provided in accordance with paragraph 1 of Section I of the Notification Protocol.
3. Each Party shall have the right to conduct data update inspections at facilities to confirm the accuracy of data on the numbers and types of items specified for such facilities in the notifications and regular exchanges of updated data provided in accordance with paragraphs 2 and 3 of Section I of the Notification Protocol.
4. Each Party shall have the right to conduct new facility inspections to confirm the accuracy of data on the numbers and types of items specified in the notifications of new facilities provided in accordance with paragraph 3 of Section I of the Notification Protocol.
5. Each Party shall have the right to conduct suspect-site inspections to confirm that covert assembly of ICBMs for mobile launchers of ICBMs or covert assembly of first stages of such ICBMs is not occurring.
6. Each Party shall have the right to conduct re-entry vehicle inspections of deployed ICBMs and SLBMs to confirm that such ballistic missiles contain no more re-entry vehicles than the number of warheads attributed to them.
7. Each Party shall have the right to conduct post-exercise dispersal inspections of deployed mobile launchers of ICBMs and their associated missiles to confirm that the number of mobile launchers of ICBMs and their associated missiles that are located at the inspected ICBM base and those that have not returned to it after completion of the dispersal does not exceed the number specified for that ICBM base.
8. Each Party shall conduct or shall have the right to conduct conversion or elimination inspections to confirm the conversion or elimination of strategic offensive arms.
9. Each Party shall have the right to conduct close-out inspections to confirm that the elimination of facilities has been completed.
10. Each Party shall have the right to conduct formerly declared facility inspections to confirm that facilities, notification of the elimination of which has been provided in accordance with paragraph 3 of Section I of the Notification Protocol, are not being used for purposes inconsistent with this Treaty.
11. Each Party shall conduct technical characteristics exhibitions, and shall have the right during such exhibitions by the other Party to conduct inspections of an ICBM and an SLBM of each type, and each variant thereof, and of a mobile launcher of ICBMs and each version of such launcher for each type of ICBM for mobile launchers of ICBMs. The purpose of such exhibitions shall be to permit the inspecting Party to confirm that technical characteristics correspond to the data specified for these items.
12. Each Party shall conduct distinguishability exhibitions for heavy bombers, former heavy bombers, and long range nuclear ALCMs, and shall have the right during such exhibitions by the other Party to conduct inspections, of:

(A) heavy bombers equipped for long range nuclear ALCMs. The purpose of such exhibitions shall be to permit the inspecting Party to confirm that the technical characteristics of each type and each variant of such heavy bombers correspond to the data specified for these items in Annex G to the Memorandum of Understanding; to demonstrate the maximum number of long range nuclear ALCMs for which a heavy bomber of each type and each variant is actually equipped; and to demonstrate that this number does not exceed the number provided for in paragraph 20 or 21 of Article V of this Treaty, as applicable;

(B) for each type of heavy bomber from any one of which a long range nuclear ALCM has been flight-tested, heavy bombers equipped for nuclear armaments other than long range nuclear ALCMs, heavy bombers equipped for non-nuclear armaments, training heavy bombers, and former heavy bombers. If. for such a type of heavy bomber, there are no heavy bombers equipped for long range nuclear ALCMs, a test heavy bomber from which a long range nuclear ALCM has been flight-tested shall be exhibited. The purpose of such exhibitions shall be to demonstrate to the inspecting Party that, for each exhibited type of heavy bomber, each variant of heavy bombers equipped for nuclear armaments other than long range nuclear ALCMs, each variant of heavy bombers equipped for non-nuclear armaments, each variant of training heavy bombers, and a former heavy bomber are

distinguishable from one another and from each variant of heavy bombers of the same type equipped for long range nuclear ALCMs; and

(C) long range nuclear ALCMs. The purpose of such exhibitions shall be to permit the inspecting Party to confirm that the technical characteristics of each type and each variant of such long range ALCMs correspond to the data specified for these items in Annex H to the Memorandum of Understanding. A further purpose of such exhibitions shall be to demonstrate differences, notification of which has been provided in accordance with paragraph 13, 14, or 15 of Section VII of the Notification Protocol, that make long range non-nuclear ALCMs distinguishable from long range nuclear ALCMs.

13. Each Party shall conduct baseline exhibitions, and shall have the right during such exhibitions by the other Party to conduct inspections, of all heavy bombers equipped for non-nuclear armaments, all training heavy bombers, and all former heavy bombers specified in the initial exchange of data provided in accordance with paragraph 1 of Section I of the Notification Protocol. The purpose of these exhibitions shall be to demonstrate to the inspecting Party that such airplanes satisfy the requirements for conversion in accordance with the Conversion or Elimination Protocol. After a long range nuclear ALCM has been flight-tested from a heavy bomber of a type, from none of which a long range nuclear ALCM had previously been flight-tested, the Party conducting the flight test shall conduct baseline exhibitions, and the other Party shall have the right during such exhibitions to conduct inspections, of 30 per cent of the heavy bombers of such type equipped for nuclear armaments other than long range nuclear ALCMs at each air base specified for such heavy bombers. The purpose of these exhibitions shall be to demonstrate to the inspecting Party the presence of specified features that make each exhibited heavy bomber distinguishable from heavy bombers of the same type equipped for long range nuclear ALCMs.

14. Each Party shall have the right to conduct continuous monitoring activities at production facilities for ICBMs for mobile launchers of ICBMs to confirm the number of ICBMs for mobile launchers of ICBMs produced.

Article XII

1. To enhance the effectiveness of national technical means of verification, each Party shall, if the other Party makes a request in accordance with paragraph 1 of Section V of the Notification Protocol, carry out the following cooperative measures:

(A) a display in the open of the road mobile launchers of ICBMs located within restricted areas specified by the requesting Party. The number of road mobile launchers of ICBMs based at the restricted areas specified in each such request shall not exceed ten per cent of the total number of deployed road mobile launchers of ICBMs of the requested Party, and such launchers shall be contained within one ICBM base for road mobile launchers of ICBMs. For each specified restricted area, the roofs of fixed structures for road mobile launchers of ICBMs shall be open for the duration of a display. The road mobile launchers of ICBMs located within the restricted area shall be displayed either located next to **or** moved halfway out of such fixed structures;

(B) a display in the open of the rail-mobile launchers of ICBMs located at parking sites specified by the requesting Party. Such launchers shall be displayed by removing the entire train from its fixed structure and locating the train within the rail garrison. The number of rail-mobile launchers of ICBMs subject to display pursuant to each such request shall include all such launchers located at no more than eight parking sites, provided that no more than two parking sites may be requested with any one rail garrison in any one request. Requests concerning specific parking sites shall include the designation for each parking site as provided for in Annex A to the Memorandum of Understanding; and

(C) a display in the open of all heavy bombers and former heavy bombers located within one air base specified by the requesting Party, except those heavy bombers and former heavy bombers that are not readily movable due to maintenance or operations. Such heavy bombers and former heavy bombers shall be displayed by removing the entire airplane from its fixed structure, if any, and locating the airplane within the air base. Those heavy bombers and former heavy bombers at the air base specified by the requesting Party that are not readily movable due to maintenance or operations shall be specified by the requested Party in a notification provided in accordance with paragraph 2 of Section V of the Notification Protocol. Such a notification shall be provided no later than 12 hours after the request for display has been made.

2. Road mobile launchers of ICBMs, rail-mobile launchers of ICBMs, heavy bombers, and former heavy bombers subject to each request pursuant to paragraph 1 of this Article shall be displayed in open view without using concealment measures. Each Party shall have the right to make seven such requests each year, but shall not request a display at any particular ICBM base for road mobile launchers of ICBMs, any particular parking site, or any particular air base more than two times each year. A Party shall have the right to request, in any single request, only a display of road mobile launchers of ICBMs, a display of rail-mobile launchers of ICBMs, or a display of heavy bombers and former heavy bombers. A display shall begin no later than 12 hours after the request is made and shall continue until 18 hours have elapsed from the time that the request was made. If the requested Party cannot conduct a display due to circumstances brought about by force majeure, it shall provide notification to the requesting Party in accordance with paragraph 3 of Section V of the Notification Protocol, and the display shall be cancelled. In such a case, the number of requests to which the requesting Party is entitled shall not be reduced.

3. A request for cooperative measures shall not be made for a facility that has been designated for inspection until such an inspection has been completed and the inspectors have departed the facility. A facility for which cooperative measures have been requested shall not be designated for inspection until the cooperative measures have been completed or until notification has been provided in accordance with paragraph 3 of Section V of the Notification Protocol.

Article XIII

1. Each Party shall have the right to conduct exercise dispersals of deployed mobile launchers of ICBMs and their associated missiles from restricted areas or rail garrisons. Such an exercise dispersal may involve either road mobile launchers of ICBMs or rail-mobile launchers of ICBMs, or both road mobile launchers of ICBMs and rail-mobile launchers of ICBMs. Exercise dispersals of deployed mobile launchers of ICBMs and their associated missiles shall be conducted as provided for below:

(A) An exercise dispersal shall be considered to have begun as of the date and time specified in the notification provided in accordance with paragraph 11 of Section II of the Notification Protocol.

(B) An exercise dispersal shall be considered to be completed as of the date and time specified in the notification provided in accordance with paragraph 12 of Section II of the Notification Protocol.

(C) Those ICBM bases for mobile launchers of ICBMs specified in the notification provided in accordance with paragraph 11 of Section II of the Notification Protocol shall be considered to be involved in an exercise dispersal.

(D) When an exercise dispersal begins, deployed mobile launchers of ICBMs and their associated missiles engaged in a routine movement from a restricted area or rail garrison of an ICBM base for mobile launchers of ICBMs that is involved in such a dispersal shall be considered to be part of the dispersal.

(E) When an exercise dispersal begins, deployed mobile launchers of ICBMs and their associated missiles engaged in a relocation from a restricted area or rail garrison of an ICBM base for mobile launchers of ICBMs that is involved in such a dispersal shall continue to be considered to be engaged in a relocation. Notification of the completion of the relocation shall be provided in accordance with paragraph 10 of Section II of the Notification Protocol, unless notification of the completion of the relocation was provided in accordance with paragraph 12 of Section II of the Notification Protocol.

(F) During an exercise dispersal, all deployed mobile launchers of ICBMs and their associated missiles that depart a restricted area or rail garrison of an ICBM base for mobile launchers of ICBMs involved in such a dispersal shall be considered to be part of the dispersal, except for such launchers and missiles that relocate to a facility outside their associated ICBM base during such a dispersal.

(G) An exercise dispersal shall be completed no later than 30 days after it begins.

(H) Exercise dispersals shall not be conducted:

(i) more than two times in any period of two calendar years;

(ii) during the entire period of time provided for baseline data inspections;

(iii) from a new ICBM base for mobile launchers of ICBMs until a new facility inspection has been conducted or until the period of time provided for such an inspection has expired; or

(iv) from an ICBM base for mobile launchers of ICBMs that has been designated for a data update inspection or re-entry vehicle inspection, until completion of such an inspection.

(I) If a notification of an exercise dispersal has been provided in accordance with paragraph 11 of Section II of the Notification Protocol, the other Party shall not have the right to designate for data update inspection or re-entry vehicle inspection an ICBM base for mobile launchers of ICBMs involved in such a dispersal, or to request cooperative measures for such an ICBM base, until the completion of such a dispersal.

(J) When an exercise dispersal is completed, deployed mobile launchers of ICBMs and their associated missiles involved in such a dispersal shall be located at their restricted areas or rail garrisons, except for those otherwise accounted for in accordance with paragraph 12 of Section II of the Notification Protocol.

2. A major strategic exercise involving heavy bombers, about which a notification has been provided pursuant to the Agreement Between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on Reciprocal Advance Notification of Major Strategic Exercises of September 23, 1989, shall be conducted as provided for below:

(A) Such exercise shall be considered to have begun as of the date and time specified in the notification provided in accordance with paragraph 16 of Section II of the Notification Protocol.

(B) Such exercise shall be considered to be completed as of the date and time specified in the notification provided in accordance with paragraph 17 of Section II of the Notification Protocol.

(C) The air bases for heavy bombers and air bases for former heavy bombers specified in the notification provided in accordance with paragraph 16 of Section II of the Notification Protocol shall be considered to be involved in such exercise.

(D) Such exercise shall begin no more than one time in any calendar year, and shall be completed no later than 30 days after it begins.

(E) Such exercise shall not be conducted during the entire period of time provided for baseline data inspections.

(F) During such exercise by a Party, the other Party shall not have the right to conduct inspections of the air bases for heavy bombers and air bases for former heavy bombers involved in the exercise. The right to conduct inspections of such air bases shall resume three days after notification of the completion of a major strategic exercise involving heavy bombers has been provided in accordance with paragraph 17 of Section II of the Notification Protocol.

(G) Within the 30-day period following the receipt of the notification of the completion of such exercise, the receiving Party may make a request for cooperative measures to be carried out in accordance with subparagraph 1(C) of Article XII of this Treaty at one of the air bases involved in the exercise. Such a request shall not be counted toward the quota provided for in paragraph 2 of Article XII of this Treaty.

Article XIV

1. Each Party shall have the right to conduct operational dispersals of deployed mobile launchers of ICBMs and their associated missiles, ballistic missile submarines, and heavy bombers. There shall be no limit on the number and duration of operational dispersals, and there shall be no limit on the number of deployed mobile launchers of ICBMs and their associated missiles, ballistic missile submarines, or heavy bombers involved in such dispersals. When an operational dispersal begins, all strategic

offensive arms of a Party shall be considered to be part of the dispersal. Operational dispersals shall be conducted as provided for below:

(A) An operational dispersal shall be considered to have begun as of the date and time specified in the notification provided in accordance with paragraph 1 of Section X of the Notification Protocol.

(B) An operational dispersal shall be considered to be completed as of the date and time specified in the notification provided in accordance with paragraph 2 of Section X of the Notification Protocol.

2. During an operational dispersal each Party shall have the right to:

(A) suspend notifications that it would otherwise provide in accordance with the Notification Protocol except for notification of flight tests provided under the Agreement Between the United States of America and the Union of Soviet Socialist Republics on Notifications of Launches of Intercontinental Ballistic Missiles and Submarine-Launched Ballistic Missiles of May 31, 1988; provided that, if any conversion or elimination processes are not suspended pursuant to subparagraph (D) of this paragraph, the relevant notifications shall be provided in accordance with Section IV of the Notification Protocol;

(B) suspend the right of the other Party to conduct inspections;

(C) suspend the right of the other Party to request cooperative measures; and

(D) suspend conversion and elimination processes for its strategic offensive arms. In such case, the number of converted and eliminated items shall correspond to the number that has actually been converted and eliminated as of the date and time of the beginning of the operational dispersal specified in the notification provided in accordance with paragraph 1 of Section X of the Notification Protocol.

3. Notifications suspended pursuant to paragraph 2 of this Article shall resume no later than three days after notification of the completion of the operational dispersal has been provided in accordance with paragraph 2 of Section X of the Notification Protocol. The right to conduct inspections and to request cooperative measures suspended pursuant to paragraph 2 of this Article shall resume four days after notification of the completion of the operational dispersal has been provided in accordance with paragraph 2 of Section X of the Notification Protocol. Inspections or cooperative measures being conducted at the time a Party provides notification that it suspends inspections or cooperative measures during an operational dispersal shall not count toward the appropriate annual quotas provided for by this Treaty.

4. When an operational dispersal is completed:

(A) All deployed road mobile launchers of ICBMs and their associated missiles shall be located within their deployment areas or shall be engaged in relocations.

(B) All deployed rail-mobile launchers of ICBMs and their associated missiles shall be located within their rail garrisons or shall be engaged in routine movements or relocations.

(C) All heavy bombers shall be located within national territory and shall have resumed normal operations. If it is necessary for heavy bombers to be located outside national territory for purposes not inconsistent with this Treaty, the Parties will immediately engage in diplomatic consultations so that appropriate assurances can be provided.

5. Within the 30 day period after the completion of an operational dispersal, the Party not conducting the operational dispersal shall have the right to make no more than two requests for cooperative measures, subject to the provisions of Article XII of this Treaty, for ICBM bases for mobile launchers of ICBMs or air bases. Such requests shall not count toward the quota of requests provided for in paragraph 2 of Article XII of this Treaty.

Article XV

To promote the objectives and implementation of the provisions of this Treaty, the Parties hereby establish the Joint Compliance and Inspection Commission. The Parties agree that, if either Party so requests, they shall meet within the framework of the Joint Compliance and Inspection Commission to:

(A) resolve questions relating to compliance with the obligations assumed;

(B) agree upon such additional measures as may be necessary to improve the viability and effectiveness of this Treaty; and

(C) resolve questions related to the application of relevant provisions of this Treaty to a new kind of strategic offensive arm, after notification has been provided in accordance with paragraph 16 of Section VII of the Notification Protocol.

Article XVI

To ensure the viability and effectiveness of this Treaty, each Party shall not assume any international obligations or undertakings that would conflict with its provisions. The Parties shall hold consultations in accordance with Article XV of this Treaty in order to resolve any ambiguities that may arise in this regard. The Parties agree that this provision does not apply to any patterns of cooperation, including obligations, in the area of strategic offensive arms, existing at the time of signature of this Treaty, between a Party and a third State.

Article XVII

1. This Treaty, including its Annexes, Protocols, and Memorandum of Understanding, all of which form integral parts thereof, shall be subject to ratification in accordance with the constitutional procedures of each Party. This Treaty shall enter into force on the date of the exchange of instruments of ratification.

2. This Treaty shall remain in force for 15 years unless superseded earlier by a subsequent agreement on the reduction and limitation of strategic offensive arms. No later than one year before the expiration of the 15-year period, the Parties shall meet to consider whether this Treaty will be extended. If the Parties so decide, this Treaty will be extended for a period of five years unless it is superseded before the expiration of that period by a subsequent agreement on the reduction and limitation of strategic offensive arms. This Treaty shall be extended for successive five-year periods, if the Parties so decide, in

accordance with the procedures governing the initial extension, and it shall remain in force for each agreed five-year period of extension unless it is superseded by a subsequent agreement on the reduction and limitation of strategic offensive arms.

3. Each Party shall, in exercising its national sovereignty, have the right to withdraw from this Treaty if it decides that extraordinary events related to the subject matter of this Treaty have jeopardized it supreme interests. It shall give notice of its decision to the other Party six months prior to withdrawal from this Treaty. Such notice shall include a statement of the extraordinary events the notifying Party regards as having jeopardized its supreme interests.

Article XVIII

Each Party may propose amendments to this Treaty. Agreed amendments shall enter into force in accordance with the procedures governing entry into force of this Treaty.

Article XIX

This Treaty shall be registered pursuant to Article 102 of the Charter of the United Nations.

Done at Moscow on July 31, 1991, in two copies, each in the English and Russian languages, both texts being equally authentic.

For the United States of America:
President of the United States of America

For the Union of Soviet Socialist Republics:
President of the Union of Soviet Socialist Republics

Treaty Between the United States of America and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms (START 2)

3 January 1993

The United States of America and the Russian Federation, hereinafter referred to as the Parties,

Reaffirming their obligations under the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms of July 31, 1991, hereinafter referred to as the START Treaty,

Stressing their firm commitment to the Treaty on the Non-Proliferation of Nuclear Weapons on July 1, 1968, and their desire to contribute to its strengthening,

Taking into account the commitment by the Republic of Belarus, the Republic of Kazakhstan, and Ukraine to accede to the Treaty on the Non-Proliferation of Nuclear Weapons of July 1, 1968, as non-nuclear-weapon States Parties,

Mindful of their undertakings with respect to strategic offensive arms under Article VI of the Treaty on the Non-Proliferation of Nuclear Weapons of July 1, 1968, and under the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26, 1972, as well as the provisions of the Joint Understanding signed by the Presidents of the United States of America and the Russian Federation on June 17, 1992, and of the Joint Statement on a Global Protection System signed by the Presidents of the United States of America and the Russian Federation on June 17, 1992,

Desiring to enhance strategic stability and predictability, and, in doing so, to reduce further strategic offensive arms, in addition to the reductions and limitations provided for in the START Treaty,

Considering that further progress toward that end will help lay a solid foundation for a world order built on democratic values that would preclude the risk of outbreak of war,

Recognizing their special responsibility as permanent members of the United Nations Security Council for maintaining international peace and security,

Taking note of United Nations General Assembly Resolution 47/52K of December 9, 1992,

Conscious of the new realities that have transformed the political and strategic relations between the Parties, and the relations of partnership that have been established between them,

Have agreed as follows:

Article I

1. Each Party shall reduce and limit its Intercontinental Ballistic Missiles (ICBMs) and ICBM launchers, Submarine-Launched Ballistic Missiles (SLBMs) and SLBM launchers, heavy bombers, ICBM warheads, SLBM warheads, and heavy bomber armaments, so that seven years after entry into force of the START Treaty and thereafter, the aggregate number for each Party, as counted in accordance with Articles III and IV of this Treaty, does not exceed, for warheads attributed to deployed ICBMs, deployed SLBMs, and deployed heavy bombers, a number between 3,800 and 4,250 or such lower number as each Party shall decide for itself, but in no case shall such number exceed 4,250.

2. Within the limitations provided for in paragraph 1 of this Article, the aggregate numbers for each Party shall not exceed:

(a) 2.160, for warheads attributed to deployed SLBMs;

(b) 1,200, for warheads attributed to deployed ICBMs of types to which more than one warhead is attributed; and

(c) 650, for warheads attributed to deployed heavy ICBMs.

3. Upon fulfillment of the obligations provided for in paragraph 1 of this Article, each Party shall further reduce and limit its ICBMs and ICBM launchers, SLBMs and SLBM launchers, heavy bombers, ICBM warheads, SLBM warheads, and heavy bomber armaments, so that no later than January 1, 2003, and thereafter, the aggregate number for each Party, as counted in accordance with Articles III and IV of this Treaty, does not exceed, for warheads attributed to deployed ICBMs, deployed SLBMs, and deployed heavy bombers, a number between 3,000 and 3,500 or such lower number as each Party shall decide for itself, but in no case shall such number exceed 3,500.

4. Within the limitations provided for in paragraph 3 of this Article, the aggregate numbers for each Party shall not exceed:

(a) a number between 1,700 and 1,750, for warheads attributed to deployed SLBMs or such lower number as each Party shall decide for itself, but in no case shall such number exceed 1,750;

(b) zero, for warheads attributed to deployed ICBMs of types to which more than one warhead is attributed; and

(c) zero, for warheads attributed to deployed heavy ICBMs.

5. The process of reductions provided for in paragraphs 1 and 2 of this Article shall begin upon entry into force of this Treaty, shall be sustained throughout the reductions period provided for in paragraph 1 of this Article, and shall be completed no later than seven years after entry into force of the START Treaty. Upon completion of these reductions, the Parties shall begin further reductions provided for in paragraphs 3 and 4 of this Article, which shall also be sustained throughout the reductions period defined in accordance with paragraphs 3 and 6 of this Article.

6. Provided that the Parties conclude, within one year after entry into force of this Treaty, an agreement on a program of assistance to promote the fulfillment of the provisions of this Article, the obligations provided for in paragraphs 3 and 4 of this Article and in Article II of this Treaty shall be fulfilled by each Party no later than December 31, 2000.

Article II

1. No later than January 1, 2003, each Party undertakes to have eliminated or to have converted to launchers of ICBMs to which one warhead is attributed all its deployed and non-deployed launchers of ICBMs to which more than one warhead is attributed under Article III of this Treaty (including test

launchers and training launchers), with the exception of those launchers of ICBMs other than heavy ICBMs at space launch facilities allowed under the STARTTreaty, and not to have thereafter launchers of ICBMs to which more than one warhead is attributed. ICBM launchers that have been converted to launch an ICBM of a different type shall not be capable of launching an ICBM of the former type. Each Party shall carry out such elimination or conversion using the procedures provided for in the START Treaty, except as otherwise provided for in paragraph 3 of this Article.

2. The obligations provided for in paragraph 1 of this Article shall not apply to silo launchers of ICBMs on which the number of warheads has been reduced to one pursuant to paragraph 2 of Article III of this Treaty.

3. Elimination of silo launchers of heavy ICBMs, including test launchers and training launchers, shall be implemented by means of either:

(a) elimination in accordance with the procedures provided for in Section II of the Protocol on Procedures Governing the Conversion or Elimination of the Items Subject to the START Treaty; or

(b) conversion to silo launchers of ICBMs other than heavy ICBMs in accordance with the procedures provided for in the Protocol on Procedures Governing Elimination of Heavy ICBMs and on Procedures Governing Conversion of Silo Launchers of Heavy ICBMs Relating to the Treaty Between the United States of America and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms, hereinafter referred to as the Elimination and Conversion Protocol. No more than 90 silo launchers of heavy ICBMs may be so converted.

4. Each party undertakes not to emplace an ICBM, the launch canister of which has a diameter greater than 2.5 meters, in any silo launcher of heavy ICBMs converted in accordance with subparagraph 3(b) of this Article.

5. Elimination of launchers of heavy ICBMs at space launch facilities shall only be carried out in accordance with subparagraph 3(a) of this Article.

6. No later than January 1, 2003, each Party undertakes to have eliminated all of its deployed and non-deployed heavy ICBMs and their launch canisters in accordance with the procedures provided for in the Elimination and Conversion Protocol or by using such missiles for delivering objects into the upper atmosphere or space, and not to have such missiles or launch canisters thereafter.

7. Each Party shall have the right to conduct inspections in connection with the elimination of heavy ICBMs and their launch canisters, as well as inspections in connection with the conversion of silo launchers of heavy ICBMs. Except as otherwise provided for in the Elimination and Conversion Protocol, such inspections shall be conducted subject to the applicable provisions of the START Treaty.

8. Each Party undertakes not to transfer heavy ICBMs to any recipient whatsoever, including any other Party to the START Treaty.

9. Beginning on January 1,2003, and thereafter, each Party undertakes not to produce, acquire, flight-test (except for flight tests from space launch facilities conducted in accordance with the provisions of the START Treaty), or deploy ICBMs to which more than one warhead is attributed under Article III of this Treatv.

Article III

1. For the purposes of attributing warheads to deployed ICBMs and deployed SLBMs under this Treaty, the Parties shall use the provisions provided for in Article III of the START Treaty, except as otherwise provided for in paragraph 2 of this Article.

2. Each Party shall have the right to reduce the number of warheads attributed to deployed ICBMs or deployed SLBMs only of existing types, except for heavy ICBMs. Reduction in the number of warheads attributed to deployed ICBMs and deployed SLBMs of existing types that are not heavy ICBMs shall be carried out in accordance with the provisions of paragraph 5 of Article III of the START Treaty, except that:

(a) the aggregate number by which warheads are reduced may exceed the 1,250 limit provided for in paragraph 5 of Article III of the START Treaty;

(b) the number by which warheads are reduced on ICBMs and SLBMs, other than the Minuteman III ICBM for the United States of America and the SS-N-18 SLBM for the Russian Federation, may at any one time exceed the limit of 500 warheads for each Party provided for in subparagraph 5(c)(i) of Article III of the START Treaty;

(c) each Party shall have the right to reduce by more than four warheads, but not by more than five warheads, the number of warheads attributed to each ICBM out of no more than 105 ICBMs of one existing type of ICBM. An ICBM to which the number of warheads attributed has been reduced in accordance with this paragraph shall only be deployed in an ICBM launcher in which an ICBM of that type was deployed as of the date of signature of the START Treaty; and

(d) the re-entry vehicle platform for an ICBM or SLBM to which a reduced number of warheads is attributed is not required to be destroyed and replaced with a new re-entry vehicle platform.

3. Notwithstanding the number of warheads attributed to a type of ICBM or SLBM in accordance with the START Treaty, each Party undertakes not to:

(a) produce, flight-test, or deploy an ICBM or SLBM with a number of re-entry vehicles greater than the number of warheads attributed to it under this Treaty; and

(b) increase the number of warheads attributed to an ICBM or SLBM that has had the number of warheads attributed to it reduced in accordance with the provisions of this Article.

Article IV

1. For the purposes of this Treaty, the number of warheads attributed to each deployed heavy bomber shall be equal to the number of nuclear weapons for which any heavy bomber of the same type or variant of a type is actually equipped, with the exception of heavy bombers reoriented to a conventional role as provided for in paragraph 7 of this Article. Each nuclear weapon for which a heavy bomber is actually equipped shall count as one warhead toward the limitations provided for in Article I of this Treaty. For the purpose of such counting, nuclear weapons include long range nuclear Air-Launched

Cruise Missiles (ALCMs), nuclear air-to-surface missiles with a range of less than 600 kilometers, and nuclear bombs.

2. For the purposes of this Treaty, the number of nuclear weapons for which a heavy bomber is actually equipped shall be the number specified for heavy bombers of that type and variant of a type in the Memorandum of Understanding on Warhead Attribution and Heavy Bomber Data Relating to the Treaty Between the United States of America and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms, hereinafter referred to as the Memorandum on Attribution.

3. Each Party undertakes not to equip any heavy bomber with a greater number of nuclear weapons than the number specified for heavy bombers of that type or variant of a type in the Memorandum on Attribution.

4. No later than 180 davs after entrv into force of this Treatv, each Party shall exhibit one heavy bomber of each type and variant of a type'specified in the Memorandum on Attribution. The purpose of the exhibition shall be to demonstrate to the other Party the number of nuclear weapons for which a heavy bomber of a given type or variant of a type is actually equipped.

5. If either Party intends to change the number of nuclear weapons specified in the Memorandum on Attribution, for which a heavy bomber of a type or variant of a type is actually equipped, it shall provide a 90-day advance notification of such intention to the other Party. Ninety days after providing such a notification, or at a later date agreed by the Parties, the Party changing the number of nuclear weapons for which a heavy bomber is actually equipped shall exhibit one heavy bomber of each such type or variant of a type. The purpose of the exhibition shall be to demonstrate to the other Party the revised number of nuclear weapons for which heavy bombers of the specified type or variant of a type are actually equipped. The number of nuclear weapons attributed to the specified type and variant of a type of heavy bomber shall change on the ninetieth day after the notification of such intent. On that day, the Party changing the number of nuclear weapons for which a heavy bomber is actually equipped shall provide to the other Party a notification of each change in data according to categories of data contained in the Memorandum of Attribution.

6. The exhibitions and inspections conducted pursuant to paragraphs 4 and 5 of this Article shall be carried out in accordance with the procedures provided for in the Protocol on Exhibitions and Inspections of Heavy Bombers Relating to the Treaty Between the United States of America and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms, hereinafter referred to as the Protocol on Exhibitions and Inspections.

7. Each Party shall have the right to reorient to a conventional role heavy bombers equipped for nuclear armaments other than long range nuclear ALCMs. For the purposes of this Treaty, heavy bombers reoriented to a conventional role are those heavy bombers specified by a Party from among its heavy bombers equipped for nuclear armaments other than long range nuclear ALCMs that have never been accountable under the START Treaty as heavy bombers equipped for long range nuclear ALCMs. The reorienting Party shall provide to the other Party a notification of its intent to reorient a heavy bomber to a conventional role no less than 90 days in advance of such reorientation. No conversion procedures shall be required for such a heavy bomber to be specified as a heavy bomber reoriented to a conventional role.

8. Heavy bombers reoriented to a conventional role shall be subject to the following requirements:

(a) the number of such heavy bombers shall not exceed 100 at any one time;

(b) such heavy bombers shall be based separately from heavy bombers with nuclear roles;

(c) such heavy bombers shall be used only for non-nuclear missions. Such heavy bombers shall not be used in exercises for nuclear missions, and their air crews shall not train or exercise for such missions; and

(d) heavy bombers reoriented to a conventional role shall have differences from other heavy bombers of that type or variant of a type that are observable by national technical means of verification and visible during inspection.

9. Each Party shall have the right to return to a nuclear role heavy bombers that have been reoriented in accordance with paragraph 7 of this Article to a conventional role. The Party carrying out such action shall provide to the other Party through diplomatic channels notification of its intent to return a heavy bomber to a nuclear role no less than 90 days in advance of taking such action. Such a heavy bomber returned to a nuclear role shall not subsequently be reoriented to a conventional role. Heavy bombers reoriented to a conventional role that are subsequently returned to a nuclear role shall have differences observable by national technical means of verification and visible during inspection from other heavy bombers of that type and variant of a type that have not been reoriented to a conventional role, as well as from heavy bombers of that type and variant of a type that are still reoriented to a conventional role.

10. Each Party shall locate storage areas for heavy bomber nuclear armaments no less than 100 kilometers from any air base where heavy bombers reoriented to a conventional role are based.

11. Except as otherwise provided for in this Treaty, heavy bombers reoriented to a conventional role shall remain subject to the provisions of the START Treaty, including the inspection provisions.

12. If not all heavy bombers of a given type or variant of a type are reoriented to a conventional role, one heavy bomber of each type or variant of a type of heavy bomber reoriented to a conventional role shall be exhibited in the open for the purpose of demonstrating to the other Party the differences referred to in subparagraph 8(d) of this Article. Such differences shall be subject to inspection by the other Party.

13. If not all heavy bombers of a given type or variant of a type reoriented to a conventional role are returned to a nuclear role, one heavy bomber of each type and variant of a type of heavy bomber returned to a nuclear role shall be exhibited in the open for the purpose of demonstrating to the other Party the differences referred to in paragraph 9 of this Article. Such differences shall be subject to inspection by the other Party.

14. The exhibitions and inspections provided for in paragraphs 12 and 13 of this Article shall be carried out in accordance with the procedures provided for in the Protocol on Exhibitions and Inspections.

Article V

1. Except as provided for in this Treaty, the provisions of the START Treaty, including the verification provisions, shall be used for implementation of this Treaty.

2. To promote the objectives and implementation of the provisions of this Treaty, the Parties hereby establish the Bilateral Implementation Commission. The Parties agree that, if either Party so requests, they shall meet within the framework of the Bilateral Implementation Commission to:

(a) resolve questions relating to compliance with the obligations assumed; and

(b) agree upon such additional measures as may be necessary to improve the viability and effectiveness of this Treaty.

Article VI

1. This Treaty, including its Memorandum on Attribution, Elimination and Conversion Protocol, and Protocol on Exhibitions and Inspections, all of which are integral parts thereof, shall be subject to ratification in accordance with the constitutional procedures of each Party. This Treaty shall enter into force on the date of the exchange of instruments of ratification, but not prior to the entry into force of the START Treaty.
2. The provisions of paragraph 8 of Article II of this Treaty shall be applied provisionally by the Parties from the date of its signature.
3. This Treaty shall remain in force so long as the START Treaty remains in force.
4. Each Party shall, in exercising its national sovereignty, have the right to withdraw from this Treaty if it decides that extraordinary events related to the subject matter of this Treaty have jeopardized its supreme interests. It shall give notice of its decision to the other Party six months prior to withdrawal from this Treaty. Such notice shall include a statement of the extraordinary events the notifying Party regards as having jeopardized its supreme interests.

Article VII

Each Party may propose amendments to this Treaty. Agreed amendments shall enter into force in accordance with the procedures governing entry into force of this Treaty.

Article VIII

This Treaty shall be registered pursuant to Article 102 of the Charter of the United Nations.

Done at Moscow on January 3, 1993, in two copies, each in the English and Russian languages, both texts being equally authentic.

FOR THE UNITED STATES OF AMERICA: FOR THE RUSSIAN FEDERATION:

Protocol on Procedures Governing Elimination of Heavy ICBMs and on Procedures Governing Conversion of Silo Launchers of Heavy ICBMs Relating to the Treaty Between the United States of America and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms (START 2)

3 January 1993

Pursuant to and in implementation of the Treaty Between the United States of America and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms, hereinafter referred to as the Treaty, the Parties hereby agree upon procedures governing the elimination of heavy ICBMs and upon procedures governing the conversion of silo launchers of such ICBMs.

I. Procedures for Elimination of Heavy ICBMs and Their Launch Canisters

1. Elimination of heavy ICBMs shall be carried out in accordance with the procedures provided for in this Section at elimination facilities for ICBMs specified in the STARTTreaty or shall be carried out by using such missiles for delivering objects into the upper atmosphere or space. Notification thereof shall be provided through the Nuclear Risk Reduction Centers (NRRCs) 30 days in advance **of** the initiation of elimination at conversion or elimination facilities, or, in the event of launch, in accordance with the provisions of the Agreement Between the United States of America and the Union of Soviet Socialist Republics on Notifications of Launches of Intercontinental Ballistic Missiles and Submarine-Launched Ballistic Missiles of May 31, 1988.
2. Prior to the confirmatory inspection pursuant to paragraph 3 of this Section, the inspected Party:
   (a) shall remove the missile's re-entry vehicles;
   (b) may remove the electronic and electromechanical devices of the missile's guidance and control system from the missile and its launch canister, and other elements that shall not be subject to elimination pursuant to paragraph 4 of this Section;
   (c) shall remove the missile from its launch canister and disassemble the missile into stages;
   (d) shall remove liquid propellant from the missile;
   (e) may remove or actuate auxiliary pyrotechnic devices installed on the missile and its launch canister;
   (f) may remove penetration aids, including devices for their attachment and release; and
   (g) may remove propulsion units from the self-contained dispensing mechanism.
These actions may be carried out in any order.
3. After arrival of the inspection team and prior to the initiation of the elimination process, inspectors shall confirm the type and number of the missiles to be eliminated by making the observations and measurements necessary for such confirmation. After the procedures provided for in this paragraph have been carried out, the process of the elimination of the missiles and their launch canisters may begin. Inspectors shall observe the elimination process.
4. Elimination process for heavy ICBMs:
   (a) missile stages, nozzle, and missile interstage skirts shall each be cut into two pieces of approximately equal size; and
   (b) the self-contained dispensing mechanism as well as the front section, including the re-entry vehicle platform and the front section shroud, shall be cut into two pieces of approximately equal size and crushed.
5. During the elimination process for launch canisters of heavy ICBMs, the launch canister shall be cut into two pieces of approximately equal size or into three pieces in such a manner that pieces no less than 1.5 meters long are cut from the ends of the body of such a launch canister.
6. Upon completion of the above requirements, the inspection team leader and a member of the in-country escort shall confirm in a factual, written report containing the results of the inspection team's observation of the elimination process that the inspection team has completed its inspection.
7. Heavy ICBMs shall cease to be subject to the limitations provided for in the Treaty after completion **of** the procedures provided for in this Section. Notification thereof shall be provided in accordance with paragraph 3 of Section I of the Notification Protocol Relating to the START Treaty.

II. Procedures for Conversion of Silo Launchers of Heavy ICBMs, Silo Training Launchers for Heavy ICBMs, and Silo Test Launchers for Heavy ICBMs

1. Conversion of silo launchers of heavy ICBMs, silo training launchers for heavy ICBMs, and silo test launchers for heavy ICBMs shall be carried out ***in situ*** and shall be subject to inspection.
2. Prior to the initiation of the conversion process for such launchers, the missile and launch canister shall be removed from the silo launcher.
3. A Party shall be considered to have initiated the conversion process for silo launchers of heavy ICBMs, silo training launchers for heavy ICBMs, and silo test launchers for heavy ICBMs as soon as the silo launcher door has been opened and a missile and its launch canister have been removed from the silo launcher. Notification thereof shall be provided in accordance with paragraphs 1 and 2 of Section IV of the Notification Protocol Relating to the START Treaty.
4. Conversion process for silo launchers of heavy ICBMs, silo training launchers for heavy ICBMs, and silo test launchers for heavy ICBMs shall include the following steps:
   (a) the silo launcher door shall be opened, the missile and the launch canister shall be removed from the silo launcher;
   (b) concrete shall be poured into the base of the silo launcher up to the height of five meters from the bottom of the silo launcher; and
   (c) a restrictive ring with a diameter of no more than 2.9 meters shall be installed into the upper portion of the silo launcher. The method **of** installation of the restrictive ring shall rule out its removal without destruction of the ring and its attachment to the silo launcher.
5. Each Party shall have the right to confirm that the procedures provided for in paragraph 4 of this Section have been carried out. For the purpose of confirming that these procedures have been carried out:

(a) the converting Party shall notify the other Party through the NRRCs:

(i) no less than 30 days in advance of the date when the process of pouring concrete will commence; and

(ii) upon completion of all of the procedures provided for in paragraph 4 of this Section; and

(b) the inspecting Party shall have the right to implement the procedures provided for in either paragraph 6 or paragraph 7, but not both, of this Section for each silo launcher of heavy ICBMs, silo training launcher for heavy ICBMs, and silo test launcher for heavy ICBMs that is to be converted.

6. Subject to the provisions of paragraph 5 of this Section, each Party shall have the right to observe the entire process of pouring concrete into each silo launcher of heavy ICBMs, silo training launcher for heavy ICBMs, and silo test launcher for heavy ICBMs that is to be converted, and to measure the diameter of the restrictive ring. For this purpose:

(a) the inspecting Party shall inform the Party converting the silo launcher no less than seven days in advance of the commencement of the pouring that it will observe the filling of the silo in question;

(b) immediately prior to the commencement of the process of pouring concrete, the converting Party shall take such steps as are necessary to ensure that the base of the silo launcher is visible, and that the depth of the silo can be measured;

(c) the inspecting Party shall have the right to observe the entire process of pouring concrete from a location providing an unobstructed view of the base of the silo launcher, and to confirm by measurement that concrete has been poured into the base of the silo launcher up to the height of five meters from the bottom of the silo launcher. The measurements shall be taken from the level of the lower edge of the closed silo launcher door to the base of the silo launcher, prior to the pouring of the concrete, and from the level of the lower edge of the closed silo launcher door to the top of the concrete fill, after the concrete has hardened;

(d) following notification of completion of the procedures provided for in paragraph 4 of this Section, the inspecting Party shall be permitted to measure the diameter of the restrictive ring. The restrictive ring shall not be shrouded during such inspections. The Parties shall agree on the date for such inspections;

(e) the results of measurements conducted pursuant to subparagraphs (c) and (d) of this paragraph shall be recorded in written, factual inspection reports and signed by the inspection team leader and a member of the in-country escort;

(f) inspection teams shall each consist of no more than 10 inspectors, all of whom shall be drawn from the list of inspectors under the START Treaty; and

(g) such inspections shall not count against any inspection quota established by the START Treaty.

7. Subject to the provisions of paragraph 5 of this Section, each Party shall have the right to measure the depth of each silo launcher of heavy ICBMs, silo training launcher for heavy ICBMs, and silo test launcher for heavy ICBMs that is to be converted both before the commencement and after the completion of the process of pouring concrete, and to measure the diameter of the restrictive ring. For this purpose:

(a) the inspecting Party shall inform the Party converting the silo launcher no less than seven days in advance of the commencement of the pouring that it will measure the depth of the silo launcher in question both before the commencement and after the completion of the process of pouring concrete;

(b) immediately prior to the commencement of the process of pouring concrete, the converting Party shall take such steps as are necessary to ensure that the base of the silo launcher is visible, and that the depth of the silo launcher can be measured;

(c) the inspecting Party shall measure the depth of the silo launcher prior to the commencement of the process of pouring concrete;

(d) following notification of completion of the procedures provided for in paragraph 4 of this Section, the inspecting Party shall be permitted to measure the diameter of the restrictive ring, and to remeasure the depth of the silo launcher. The restrictive ring shall not be shrouded during such inspections. The Parties shall agree on the date for such inspections;

(e) for the purpose of measuring the depth of the concrete in the silo launcher, measurements shall be taken from the level of the lower edge of the closed silo launcher door to the base of the silo launcher, prior to the pouring of the concrete, and from the level of the lower edge of the closed silo launcher door to the top of the concrete fill, after the concrete has hardened;

(f) the results of measurements conducted pursuant to subparagraphs (c), (d), and (e) of this paragraph shall be recorded in written, factual inspection reports and signed by the inspection team leader and a member of the in-country escort;

(g) inspection teams shall each consist of no more than 10 inspectors, all of whom shall be drawn from the list of inspectors under the START Treaty; and

(h) such inspections shall not count against any inspection quota established by the START Treaty.

8. The converting Party shall have the right to carry out further conversion measures after the completion of the procedures provided for in paragraph 6 or paragraph 7 of this Section or, if such procedures are not conducted, upon expiration of 30 days after notification of completion of the procedures provided for in paragraph 4 of this Section.

9. In addition of the re-entry vehicle inspections conducted under the START Treaty, each Party shall have the right to conduct, using the procedures provided for in Annex 3 to the Inspection Protocol Relating to the START Treaty, four additional re-entry vehicle inspections each year of ICBMs that are deployed in silo launchers of heavy ICBMs that have been converted in accordance with the provisions of this Section. During such inspections, the inspectors also shall have the right to confirm by visual observation the presence of the restrictive ring and that the observable portions of the launch canister do not differ externally from the observable portions of the launch canister that was exhibited pursuant to paragraph 11 of Article XI of the START Treaty. Any shrouding of the upper portion of the silo launcher shall not obstruct visual observation of the upper portion of the launch canister and shall not obstruct visual observation of the edge of the restrictive ring. If requested by the inspecting Party, the converting Party shall partially remove any shrouding, except for shrouding of instruments installed on the restrictive ring, to permit confirmation of the presence of the restrictive ring.

10. Upon completion of the procedures provided for in paragraph 6 or paragraph 7 of this Section or, if such procedures are not conducted, upon expiration of 30 days after notification of completion of the procedures provided for in paragraph 4 of this Section, the silo launcher of heavy ICBMs being converted shall, for the purposes of theTreaty, be considered to contain a deployed ICBM to which one warhead is attributed.

III. Equipment; Costs

1. To carry out inspections provided for in this Protocol, the inspecting Party shall have the right to use agreed equipment, including equipment that will confirm that the silo launcher has been completely filled up to the height of five meters from the bottom of the silo launcher with concrete. The Parties shall agree in the Bilateral Implementation Commission on such equipment.
2. For inspections conducted pursuant to this Protocol, costs shall be handled pursuant to paragraph 19 of Section V of the Inspection Protocol Relating to the START Treaty.

This Protocol is an integral part of the Treaty and shall enter into force on the date of entry into force of the Treaty and shall remain in force as long as the Treaty remains in force. As provided for in subparagraph 2(b) of Article V of the Treaty, the Parties may agree upon such additional measures as may be necessary to improve the viability and effectiveness of the Treaty. The Parties agree that, if it becomes necessary to make changes in this Protocol that do no affect substantive rights or obligations under the Treaty, they shall use the Bilateral Implementation Commission to reach agreement on such changes, without resorting to the procedure for making amendments set forth in Article VII of the Treaty.

DONE at Moscow on January 3, 1993, in two copies, each in the English and Russian languages, both texts being equally authentic.

FOR THE UNITED STATES OF AMERICA: FOR THE RUSSIAN FEDERATION:

Protocol on Exhibitions and Inspections of Heavy Bombers Relating to the Treaty Between the United States of America and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms (START 2)

3 January 1993

Pursuant to and in implementation of the Treaty Between the United States of America and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms, hereinafter referred to as the Treaty, the Parties hereby agree to conduct exhibitions and inspections of heavy bombers pursuant to paragraphs 4, 5, 12, and 13 of Article IV of the Treaty.

I. Exhibitions of Heavy Bombers

1. For the purpose of helping to ensure verification of compliance with the provisions of the Treaty, and as required by paragraphs 4, 5, 12, and 13 of Article IV of the Treaty, each Party shall conduct exhibitions of heavy bombers equipped for nuclear armaments, heavy bombers reoriented to a conventional role, and heavy bombers that were reoriented to a conventional role and subsequently returned to a nuclear role.

2. The exhibitions of heavy bombers shall be conducted subject to the following provisions:

(a) the location for such an exhibition shall be at the discretion of the exhibiting Party;

(b) the date for such an exhibition shall be agreed upon between the Parties through diplomatic channels, and the exhibiting Party shall communicate the location of the exhibition;

(c) during such an exhibition, each heavy bomber exhibited shall be subject to inspection for a period not to exceed two hours;

(d) the inspection team conducting an inspection during an exhibition shall consist of no more than 10 inspectors, all of whom shall be drawn from the list of inspectors under the START Treaty;

(e) prior to the beginning of the exhibition, the inspected Party shall provide a photograph or photographs of one of the heavy bombers of a type or variant of a type reoriented to a conventional role and of one of the heavy bombers of the same type and variant of a type that were reoriented to a conventional role and subsequently returned to a nuclear role, so as to show all of their differences that are observable by national technical means of verification and visible during inspection; and

(f) such inspections during exhibitions shall not count against any inspection quota established by the START Treaty.

II. Inspections of Heavy Bombers

1. During exhibitions of heavy bombers, each Party shall have the right to perform the following procedures on the exhibited heavy bombers; and each Party, beginning 180 days after entry into force of the Treaty and thereafter, shall have the right, in addition to its rights under the START Treaty, to perform, during data update and new facility inspections conducted under the START Treaty at air bases of the other Party, the following procedures on all heavy bombers based at such air bases and present there at the time of the inspection:

(a) to conduct inspections of heavy bombers equipped for long range nuclear ALCMs and heavy bombers equipped for nuclear armaments other than long range nuclear ALCMs, in order to confirm that the number of nuclear weapons for which a heavy bomber is actually equipped does not exceed the number specified in the Memorandum on Attribution. The inspection team shall have the right to visually inspect those portions of the exterior of the inspected heavy bomber where the inspected heavy bomber is equipped for weapons, as well as to visually inspect the weapons bay of such a heavy bomber, but not to inspect other portions of the exterior or interior;

(b) to conduct inspections of heavy bombers reoriented to a conventional role, in order to confirm the differences of such heavy bombers from other heavy bombers of that type or variant of a type that are observable by national technical means of verification and visible during inspection. The inspection team shall have the right to visually inspect those portions of the exterior of the inspected heavy bomber having the differences observable by national technical means of verification and visible during inspection, but not to inspect other portions of the exterior or interior; and

(c) to conduct inspections of heavy bombers that were reoriented to a conventional role and subsequently returned to a nuclear role, in order to confirm the differences of such heavy bombers from other heavy bombers of that type or variant of a type that are observable by national technical means of verification and visible during inspection, and to confirm that the number of nuclear weapons for which a heavy bomber is actually equipped does not exceed the number specified in the Memorandum on Attribution. The inspection team shall have the right to visually inspect those portions of the exterior of the inspected heavy bomber where the inspected heavy bomber is equipped for weapons, as well as to visually inspect the weapons bay of such a heavy bomber, and to visually inspect those portions of the exterior of the inspected heavy bomber having the differences observable by national technical means of verification and visible to inspection, but not to inspect other portions of the exterior or interior.

2. At the discretion of the inspected Party, those portions of the heavy bomber that are not subject to inspection may be shrouded. The period of time required to carry out the shrouding process shall not count against the period allocated for inspection.

3. In the course of an inspection conducted during an exhibition, a member of the in-country escort shall provide, during inspections conducted pursuant to subparagraph 1(a) or subparagraph 1(c) of this Section, explanations to the inspection team concerning the number of nuclear weapons for which the heavy bomber is actually equipped, and shall provide, during inspections conducted pursuant to subparagraph 1(b) **or** subparagraph 1(c) of this Section, explanations to the inspection team concerning the differences that are observable by national technical means of verification and visible during inspection.

This Protocol is an integral part of the Treaty and shall enter into force on the date of entry into force of the Treaty and shall remain in force so long as the Treaty remains in force. As provided for in

subparagraph 2(b) of Article V of the Treaty. the Parties may agree upon such additional measures as may be necessary to improve the viability and effectiveness of the Treaty. The Parties agree that, if it becomes necessary to make changes in this Protocol that do not affect substantive rights or obligations under the Treaty, they shall use the Bilateral Implementation Commission to reach agreement on such changes, without resorting to the procedure for making amendments set forth in Article VII of the Treaty.

DONE at Moscow on January 3, 1993, in two copies, each in the English and Russian languages, both texts being equally authentic.

FOR THE UNITED STATES OF AMERICA: FOR THE RUSSIAN FEDERATION:

Memorandum of Understanding on Warhead Attribution and Heavy Bomber Data Relating to the Treaty Between the United States of Americaand the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms (START 2)

3 January 1993

Pursuant to and in implementation of the Treaty Between the United States of America and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms, hereinafter referred to as the Treaty, the Parties have exchanged data current as of January 3, 1993, on the number of nuclear weapons for which each heavy bomber of a type and a variant of a type equipped for nuclear weapons is actually equipped. No later than 30 days after the date of entry into force of the Treaty, the Parties shall additionally exchange data, current as of the date of entry into force of the Treaty, according to the categories of data contained in this Memorandum, on heavy bombers equipped for nuclear weapons; on heavy bombers specified as reoriented to a conventional role, and on heavy bombers reoriented to a conventional role that are subsequently returned to a nuclear role; on ICBMs and SLBMs to which a reduced number of warheads is attributed; and on data on the elimination of heavy ICBMs and on conversion of silo launchers of heavy ICBMs.

Only those data used for purposes of implementing the Treaty that differ from the data in the Memorandum of Understanding on the Establishment of the Data Base Relating to the START Treaty are included in this Memorandum.

I. Number of Warheads Attributed to Deployed Heavy Bombers Other than Heavy Bombers Reoriented to a Conventional Role

1. Pursuant to paragraph 3 of Article IV of the Treaty each Party undertakes not to have more nuclear weapons deployed on heavy bombers of any type or variant of a type than the number specified in this paragraph. Additionally, pursuant to paragraph 2 of Article IV of the Treaty, for each Party the numbers of warheads attributed to deployed heavy bombers not reoriented to a conventional role as of the date of signature of the Treaty or to heavy bombers subsequently deployed are listed below. Such numbers shall only be changed in accordance with paragraph 5 of Article IV of the Treaty. The Party making a change shall provide a notification to the other Party 90 days prior to making such a change. An exhibition shall be conducted to demonstrate the changed number of nuclear weapons for which heavy bombers of the listed type or variant of a type are actually equipped:

(a) United States of America Heavy Bomber Type and Variant of a Type*

and Variant of a Type*	Number of Warheads
B-52 G	12
B-52H	20
B-1B	16
B-2	16
Aggregate Number of Warheads Attributed to Deployed Heavy Bombers, Except for Heavy Bombers Reoriented to a Conventional Role	_______

(b) Russian Federation Heavy Bomber Type and Variant of a Type

Variant of a Type	Number of Warheads
Bear B	1
Bear G	2
Bear H6	6
Bear H16	16
Blackjack	12
Aggregate Number of Warheads Attributed to Deployed Heavy Bombers, Except for Heavy Bombers Reoriented to a Conventional Role	_______

*Heavy bombers of the type and variant of a type designated B-52C, B-52D, B-52E, and B-52F, located at the Davis-Monthan conversion or elimination facility as of September 1, 1990, as specified in the Memorandum of Understanding to the START Treaty, will be eliminated, under the provisions of the START Treaty, before the expiration of the seven-year reductions period.

II. Data on Heavy Bombers Reoriented to a Conventional Role and Heavy Bombers Reoriented to a Conventional Role that Have Subsequently Been Returned to a Nuclear Role

1. For each Party, the numbers of heavy bombers reoriented to a conventional role are as follows:

(a) United States of America Heavy Bomber Type and Variant of a Type

and Variant of a Type	Number
_______	_______
_______	_______

(b) Russian Federation Heavy Bomber Type and Variant of a Type	Number
______	______
______	______

2. For each Party, the numbers of heavy bombers reoriented to a conventional role as well as data on related air bases are as follows:

(a) United States of America Air Bases: Name/Location	Bomber Type and Variant of a Type
______	______
Heavy Bombers Reoriented to a Conventional Role	Number
	______

(b) Russian Federation Air Bases: Name/Location	Bomber Type and Variant of a Type
______	______
Heavv Bombers Reoriented to a Conventional Role	Number
	______

3. For each Party, the differences observable by national technical means of verification for heavy bombers reoriented to a conventional role are as follows:

(a) United States of America Heavy Bomber Type and Variant of a Type	Difference
______	______

(b) Russian Federation Heavy Bomber Type and Variant of a Type	Difference
______	______

4. For each Party, the differences observable by national technical means of verification for heavy bombers reoriented to a conventional role that have subsequently been returned to a nuclear role are as follows:

(a) United States of America Heavy Bomber Type and Variant of a Type	Difference
______	______

(b) Russian Federation Heavy Bomber Type and Variant of a Type	Difference
______	______

III. Data on Deployed ICBMs and Deployed SLBMs to Which a Reduced Number of Warheads is Attributed

For each Party, the data on ICBM bases or submarine bases, and on ICBMs or SLBMs of existing types deployed at those bases, on which the number of warheads attributed to them is reduced pursuant to Article III of the Treaty are as follows:

(a) United States of America

	Type of ICBM or SLBM
Deployed ICBMs or Deployed SLBMs on Which the Number of Warheads Is Reduced	______
Warheads Attributed to Each Deployed ICBM or Deployed SLBM After Reduction in the Number of Warheads on It	______
Number of Warheads by Which the Original Attribution of Warheads for Each ICBM or SLBM Was Reduced	______
Aggregate Reduction in the Number of Warheads	

Attributed to Deployed ICBMs or Deployed SLBMs of that Type ______

ICBM Bases at Which the Number of Warheads on Deployed ICBMs Is Reduced:

Name/Location	ICBM Type on Which the Number of Warheads is Reduced
Deployed ICBMs on Which the Number of Warheads Is Reduced	______
Warheads Attributed to Each Deployed ICBM After Reduction in the Number of Warheads on It	______
Number of Warheads by Which the Original Attribution of Warheads for Each ICBM Was Reduced	______
Aggregate Reduction in the Number of Warheads Attributed to Deployed ICBMs of that Type	______

SLBM Bases at Which the Number of Warheads on Deployed SLBMs Is Reduced:

Name/Location	SLBM Type on Which the Number of Warheads Is Reduced
Deployed SLBMs on Which the Number of Warheads Is Reduced	______
Warheads Attributed to Each Deployed SLBM After Reduction in the Number of Warheads on It	______
Number of Warheads by Which the Original Attribution of Warheads for Each SLBM Was Reduced	______
Aggregate Reduction in the number of Warheads Attributed to Deployed SLBMs of that Type	______

(b) Russian Federation

	Type of ICBM or SLBM
Deployed ICBMs or Deployed SLBMs on Which the Number of Warheads Is Reduced	______
Warheads Attributed to Each Deployed ICBM or Deployed SLBM After Reduction in the Number of Warheads on It	______
Number of Warheads by Which the Original Attribution of Warheads for Each ICBM or SLBM Was Reduced	______
Aggregate Reduction in the Number of Warheads Attributed to Deployed ICBMs or Deployed SLBMs of that Type	______

ICBM Bases at Which the Number of Warheads on Deployed ICBMs Is Reduced:

Name/Location	ICBM Type on Which the Number of Warheads is Reduced
Deployed ICBMs on Which the Number of Warheads Is Reduced	______
Warheads Attributed to Each Deployed ICBM After Reduction in the Number of Warheads on It	______
Number of Warheads by Which the Original Attribution of Warheads for Each ICBM Was Reduced	______
Aggregate Reduction in the Number of Warheads Attributed to Deployed ICBMs of that Type	______

SLBM Bases at Which the Number of Warheads on Deployed ICBMs Is Reduced:

Name/Location	SLBM Type on Which the Number of Warheads Is Reduced
Deployed SLBMs on Which the Number of Warheads Is Reduced	______
Warheads Attributed to Each Deployed SLBM After Reduction in the Number of Warheads on It	______
Number of Warheads by Which the Original Attribution of Warheads for Each SLBM Was Reduced	______
Aggregate Reduction in the Number of Warheads Attributed to Deployed SLBMs of that Type	______

IV. Data on Eliminated Heavy ICBMs and Converted Silo Launchers of Heavy ICBMs

1. For each Party, the numbers of silo launchers of heavy ICBMs converted to silo launchers of ICBMs other than heavy ICBMs are as follows:

(a) United States of America

Aggregate Number of Converted Silo Launchers ______

ICBM Base for Silo Launchers of ICBMs: Name/Location	ICBM Type Installed in a Converted Silo Launcher
______	

Silo Launcher Group: (designation)

______

Silo Launchers:

______

(b) Russian Federation

Aggregate Number of Converted Silo Launchers ______

ICBM Base for Silo Launchers of ICBMs: Name/Location	ICBM Type Installed in a Converted Silo Launcher
______	

Silo Launcher Group: (designation)

______

Silo Launchers:

______

2. For each Party, the aggregate numbers of heavy ICBMs and eliminated heavy ICBMs are as follows:

(a) United States of America	Number
Deployed Heavy ICBMs	______
Non-Deployed Heavy ICBMs	______
Eliminated Heavy ICBMs	______

(b) Russian Federation	Number
Deployed Heavy ICBMs	______
Non-Deployed Heavy ICBMs	______
Eliminated heavy ICBMs	______

V. Changes

Each Party shall notify the other Party of changes in the attribution and data contained in this Memorandum.

The Parties, in signing this Memorandum, acknowledge the acceptance of the categories of data contained in this Memorandum and the responsibility of each Party for the accuracy only of its own data.

This Memorandum is an integral part of the Treaty and shall enter into force on the date of entry into force of the Treaty and shall remain in force so long as the Treaty remains in force. As provided for in subparagraph 2(b) of Article V of the Treaty, the Parties may agree on such additional measures as may be necessary to improve the viability and effectiveness of the Treaty. The Parties agree that, if it becomes necessary to change the categories of data contained in this Memorandum or to make other changes to this Memorandum that do not affect substantive rights or obligations under the Treaty, they shall use the Bilateral Implementation Commission to reach agreement on such changes, without resorting to the procedure for making amendments set forth in Article VII of the Treaty.

DONE at Moscow on January 3, 1993, in two copies, each in the English and Russian languages, both texts being equally authentic.

FOR THE UNITED STATES OF AMERICA: FOR THE RUSSIAN FEDERATION:

Protocol To The Treaty Between The United States Œ America And The Russian Federation On Further Reduction And Limitation Œ Strategic Offensive Arms Œ January 3 1993

September 26 1997

The United States of America and the Russian Federation,

Reaffirming their commitment to the further reduction and limitation of strategic offensive arms,

Desiring to enhance the viability and effectiveness of the Treaty Between the United States of America and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms of January 3 1993, hereinafter referred to as the Treaty,

Have agreed as follows:

Article I

1. In paragraph 1 of Article I of the Treaty the words "seven years after entry into force of the START Treaty" shall be replaced by the words "no later than December 31 2004."

2. In paragraph 3 of Article I of the Treaty the words "January 1 2003" shall be replaced by the words "December 31 2007."

3. In paragraph 5 of Article I of the Treaty the words "seven years after entry into force of the START Treaty" shall be replaced by the words "December 31 2004."

4. Paragraph 6 of Article I of the Treaty shall be formulated in the following way:
"The Parties may conclude an agreement on a program of assistance for the purpose of facilitating implementation of the provisions of this Article, including for the purpose of accelerating such implementation."

Article II

In paragraph 1, paragraph 6, and paragraph 9 of Article II of the Treaty the words "January 1 2003" shall be replaced in each case by the words "December 31 2007."

Article III

1. This Protocol shall be subject to ratification and shall enter into force on the date of exchange of instruments of ratification.

2. This Protocol is an integral part of the Treaty and shall remain in force for the duration of the Treaty.

DONE at New York City on September 26 1997, in two copies, each in the English and Russian languages, both tests being equally authentic.

Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons And on Their Destruction (CWC)

15 January 1993

Preamble

The States Parties to this Convention,

Determined to act with a view to achieving effective progress towards general and complete disarmament under strict and effective international control, including the prohibition and elimination of all types of weapons of mass destruction,

Desiring to contribute to the realization of the purposes and principles of the Charter of the United Nations,

Recalling that the General Assembly of the United Nations has repeatedly condemned all actions contrary to the principles and objectives of the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925 (the Geneva Protocol of 1925).

Recognizing that this Convention reaffirms principles and objectives of and obligations assumed under the Geneva Protocol of 1925, and the Convention on the Prohibition of the Development. Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction signed at London, Moscow and Washington on 10 April 1972,

Bearing in mind the objective contained in Article IX of the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction,

Determined for the sake of all mankind, to exclude completely the possibility of the use of chemical weapons, through the implementation of the provisions of this Convention, thereby complementing the obligations assumed under the Geneva Protocol of 1925,

Recognizing the prohibition, embodied in the pertinent agreements and relevant principles of international law, of the use of herbicides as a method of warfare,

Considering that achievements in the field of chemistry should be used exclusively for the benefit of mankind,

Desiring to promote free trade in chemicals as well as international cooperation and exchange of scientific and technical information in the field of chemical activities for purposes not prohibited under this Convention in order to enhance the economic and technological development of all States Parties,

Convinced that the complete and effective prohibition of the development, production, acquisition, stockpiling, retention, transfer and use of chemical weapons, and their destruction, represent a necessary step towards the achievement of these common objectives,

Having agreed as follows:

Article I: General Obligations

1. Each State Party to this Convention undertakes never under any circumstances:
   (a) To develop, produce, otherwise acquire, stockpile or retain chemical weapons, or transfer, directly or indirectly, chemical weapons to anyone;
   (b) To use chemical weapons;
   (c) To engage in any military preparations to use chemical weapons;
   (d) To assist, encourage or induce, in any way, anyone to engage in any activity prohibited to a State Party under this Convention.
2. Each State Party undertakes to destroy chemical weapons it owns or possesses, or that are located in any place under its jurisdiction or control, in accordance with the provisions of this Convention.
3. Each State Party undertakes to destroy all chemical weapons it abandoned on the territory of another State Party, in accordance with the provisions of this Convention.
4. Each State Party undertakes to destroy any chemical weapons production facilities it owns or possesses, or that are located in any place under its jurisdiction or control, in accordance with the provisions of this Convention.
5. Each State Party undertakes not to use riot control agents as a method of warfare.

Article II: Definitions and Criteria

For the purposes of this Convention:
1. "Chemical Weapons" means the following, together or separately:
   (a) Toxic chemicals and their precursors, except where intended for purposes not prohibited under this Convention, as long as the types and quantities are consistent with such purposes;
   (b) Munitions and devices, specifically designed to cause death or other harm through the toxic properties of those toxic chemicals specified in subparagraph (a). which would be released as a result of the employment of such munitions and devices;
   (c) Any equipment specifically designed for use directly in connection with the employment of munitions and devices specified in subparagraph (b).
2. "Toxic Chemical" means:

Any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals. This includes all such chemicals, regardless of their origin or of their method of production, and regardless of whether they are produced in facilities, in munitions or elsewhere.

(For the purpose of implementing this Convention, toxic chemicals which have been identified for the application of verification measures are listed in Schedules contained in the Annex on Chemicals.)

3. "Precursor" means:

Any chemical reactant which takes part at any stage in the production by whatever method of a toxic chemical. This includes any key component of a binary or multicomponent chemical system.

(For the purpose of implementing this Convention, precursors which have been identified for the application of verification measures are listed in Schedules contained in the Annex on Chemicals.)

4. "Key Component of Binary or Multicomponent Chemical Systems" (hereinafter referred to as "key component") means:

The precursor which plays the most important role in determining the toxic properties of the final product and reacts rapidly with other chemicals in the binary or multicomponent system.

5. "Old Chemical Weapons" means:

(a) Chemical weapons which were produced before 1925; or

(b) Chemical weapons produced in the period between 1925 and 1946 that have deteriorated to such extent that they can no longer be used as chemical weapons.

6. "Abandoned Chemical Weapons" means:

Chemical weapons, including old chemical weapons, abandoned by a State after 1 January 1925 on the territory of another State without the consent of the latter.

7. "Riot Control Agent" means:

Any chemical not listed in a Schedule, which can produce rapidly in humans sensory irritation or disabling physical effects which disappear within a short time following termination of exposure.

8. "Chemical Weapons Production Facility":

(a) Means any equipment, as well as any building housing such equipment, that was designed, constructed or used at any time since 1 January 1946:

(i) As part of the stage in the production of chemicals ("final technological stage") where the material flows would contain, when the equipment is in operation:

(1) Any chemical listed in Schedule 1 in the Annex on Chemicals, or

(2) Any other chemical that has no use, above 1 tonne per year on the territory of a State Party or in any other place under the jurisdiction or control of a State Party, for purposes not prohibited under this Convention, but can be used for chemical weapons purposes; or

(ii) For filling chemical weapons, including, ***inter alia,*** the filling of chemicals listed in Schedule 1 into munitions, devices or bulk storage containers the filling of chemicals into Containers that form part of assembled binary munitions and devices or into chemical submunitions that form part of assembled unitary munitions and devices, and the loading of the containers and chemical submunitions into the respective munitions and devices;

(b) Does not mean:

(i) Any facility having a production capacity for synthesis of chemicals specified in subparagraph (a)(i) that is less than 1 tonne;

(ii) Any facility in which a chemical specified in subparagraph (a)(i) is or was produced as an unavoidable by-product of activities for purposes not prohibited under this Convention, provided that the chemical does not exceed 3 per cent of the total product and that the facility is subject to declaration and inspection under the Annex on Implementation and Verification (hereinafter referred to as "Verification Annex"); or

(iii) The single small-scale facility for production of chemicals listed in Schedule 1 for purposes not prohibited under this Convention as referred to in Part VI of the Verification Annex.

9. "Purposes Not Prohibited Under this Convention" means:

(a) Industrial, agricultural, research, medical, pharmaceutical or other peaceful purposes:

(b) Protective purposes, namely those purposes directly related to protection against toxic chemicals and to protection against chemical weapons;

(c) Military purposes not connected with the use of chemical weapons and not dependent on the use of the toxic properties of chemicals as a method of warfare;

(d) Law enforcement including domestic riot control purposes.

10. "Production Capacity" means:

The annual quantitative potential for manufacturing a specific chemical based on the technological process actually used or, if the process is not yet operational, planned to be used at the relevant facility. It shall be deemed to be equal to the nameplate capacity or, if the nameplate capacity is not available, to the design capacity. The nameplate capacity is the product output under conditions optimized for maximum quantity for the production facility, as demonstrated by one or more test-runs. The design capacity is the corresponding theoretically calculated product output.

11. "Organization" means the Organization for the Prohibition of Chemical Weapons established pursuant to Article VIII of this Convention.

12. For the purposes of Article VI:

(a) "Production" of a chemical means its formation through chemical reaction;

(b) "Processing" of a chemical means a physical process, such as formulation, extraction and purification, in which a chemical is not converted into another chemical;

(c) "Consumption" of a chemical means its conversion into another chemical via a chemical reaction.

Article III: Declarations

1. Each State Party shall submit to the Organization, not later than 30 days after this Convention enters into force for it, the following declarations, in which it shall:

(a) With respect to chemical weapons:

(i) Declare whether it owns or possesses any chemical weapons, or whether there are any chemical weapons located in any place under its jurisdiction or control;

(ii) Specify the precise location, aggregate quantity and detailed inventory of chemical weapons it owns or possesses, or that are located in any place under its jurisdiction or control, in accordance with Part IV (A), paragraphs 1 to 3, of the Verification Annex, except for those chemical weapons referred to in sub-subparagraph (iii);

(iii) Report any chemical weapons on its territory that are owned and possessed by another State and located in any place under the jurisdiction or control of another State, in accordance with Part IV (A), paragraph 4, of the Verification Annex;

(iv) Declare whether it has transferred or received, directly or indirectly, any chemical weapons since 1 January 1946 and specify the transfer or receipt of such weapons, in accordance with Part IV (A), paragraph 5, of the Verification Annex:

(v) Provide its general plan for destruction of chemical weapons that it owns or possesses, or that are located in any place under its jurisdiction or control, in accordance with Part IV (A), paragraph 6, of the Verification Annex;

(b) With respect to old chemical weapons and abandoned chemical weapons:

(i) Declare whether it has on its territory old chemical weapons and provide all available information in accordance with Part IV (B), paragraph 3, of the Verification Annex;

(ii) Declare whether there are abandoned chemical weapons on its territory and provide all available information in accordance with Part IV (B), paragraph 8, of the Verification Annex;

(iii) Declare whether it has abandoned chemical weapons on the territory of other States and provide all available information in accordance with Part IV (B), paragraph 10, of the Verification Annex;

(c) With respect to chemical weapons production facilities:

(i) Declare whether it has or has had any chemical weapons production facility under its ownership or possession, or that is or has been located in any place under its jurisdiction or control at any time since 1 January 1946;

(ii) Specify any chemical weapons production facility it has or has had under its ownership or possession or that is or had been located in any place under its jurisdiction or control at any time since 1 January 1946, in accordance with Part V, paragraph 1, of the Verification Annex, except for those facilities referred to in sub-subparagraph (iii);

(iii) Report any chemical weapons production facility on its territory that another State has or has had under its ownership and possession and that is or has been located in any place under the jurisdiction or control of another State at any time since 1 January 1946, in accordance with Part V, paragraph 2, of the Verification Annex;

(iv) Declare whether it has transferred or received, directly or indirectly, any equipment for the production of chemical weapons since 1 January 1946 and specify the transfer or receipt of such equipment, in accordance with Part V, paragraphs 3 to 5, of the Verification Annex;

(v) Provide its general plan for destruction of any chemical weapons production facility it owns or possesses, or that is located in any place under its jurisdiction or control, in accordance with Part V, paragraph 6, of the Verification Annex;

(vi) Specify actions to be taken for closure of any chemical weapons production facility it owns or possesses, or that is located in any place under its jurisdiction or control, in accordance with Part V, paragraph 1 (i), of the Verification Annex;

(vii) Provide its general plan for any temporary conversion of any chemical weapons production facility it owns or possesses, or that is located in any place under its jurisdiction or control, into a chemical weapons destruction facility, in accordance with Part V, paragraph 7, of the Verification Annex;

(d) With respect to other facilities:

Specify the precise location, nature and general scope of activities of any facility or establishment under its ownership or possession, or located in any place under its jurisdiction or control, and that has been designed, constructed or used since 1 January 1946 primarily for development of chemical weapons. Such declaration shall include, ***inter** alia,* laboratories and test and evaluation sites;

(e) With respect to riot control agents: Specify the chemical name, structural formula and Chemical Abstracts Service (CAS) registry number, if assigned, of each chemical it holds for riot control purposes. This declaration shall be updated not later than 30 days after any change becomes effective.

2. The provisions of this Article and the relevant provisions of Part IV of the Verification Annex shall not, at the discretion of a State Party, apply to chemical weapons buried on its territory before 1 January 1977 and which remain buried, or which had been dumped at sea before 1 January 1985.

Article IV: Chemical Weapons

1. The provisions of this Article and the detailed procedures for its implementation shall apply to all chemical weapons owned or possessed by a State Party, or that are located in any place under its jurisdiction or control, except old chemical weapons and abandoned chemical weapons to which Part IV (B) of the Verification Annex applies.
2. Detailed procedures for the implementation of this Article are set forth in the Verification Annex.
3. All locations at which chemical weapons specified in paragraph 1 are stored or destroyed shall be subjectto systematicverificationthrough on-site inspection and monitoring with on-site instruments, in accordance with Part IV (A) of the Verification Annex.
4. Each State Party shall, immediately after the declaration under Article III, paragraph 1, has been submitted, provide access to chemical weapons specified in paragraph 1 for the purpose of systematic verification of the declaration through on-site inspection. Thereafter, each State Party shall not remove any of these chemical weapons, except to a chemical weapons destruction facility. It shall provide access to such chemical weapons, for the purpose of systematic on-site verification.
5. Each State Party shall provide access to any chemical weapons destruction facilities and their storage areas, that it owns or possesses, or that are located in any place under its jurisdiction or control, for the purpose of systematic verification through on-site inspection and monitoring with on-site instruments.
6. Each State Party shall destroy all chemical weapons specified in paragraph 1 pursuant to the Verification Annex and in accordance with the agreed rate and sequence of destruction (hereinafter referred to as "order of destruction"). Such destruction shall begin not later than two years after this

Convention enters into force for it and shall finish not later than 10 years after entry into force of this Convention. A State Party is not precluded from destroying such chemical weapons at a faster rate.
7. Each State Party shall:
(a) Submit detailed plans for the destruction of chemical weapons specified in paragraph 1 not later than 60 days before each annual destruction period begins, in accordance with Part IV (A), paragraph 29, of the Verification Annex; the detailed plans shall encompass all stocks to be destroyed during the next annual destruction period:
(b) Submit declarations annually regarding the implementation of its plans for destruction of chemical weapons specified in paragraph 1, not later than 60 days after the end of each annual destruction period; and
(c) Certify, not later than 30 days after the destruction process has been completed, that all chemical weapons specified in paragraph 1 have been destroyed.
8. If a State ratifies or accedes to this Convention after the 10 year period for destruction set forth in paragraph 6, it shall destroy chemical weapons specified in paragraph 1 as soon as possible. The order of destruction and procedures for stringent verification for such a State Party shall be determined by the Executive Council.
9. Any chemical weapons discovered by a State Party after the initial declaration of chemical weapons shall be reported, secured and destroyed in accordance with Part IV (A) of the Verification Annex.
10. Each State Party, during transportation, sampling, storage and destruction of chemical weapons, shall assign the highest priority to ensuring the safety of people and to protecting the environment. Each State Party shall transport, sample, store and destroy chemical weapons in accordance with its national standards for safety and emissions.
11. Any State Party which has on its territory chemical weapons that are owned or possessed by another State, or that are located in any place under the jurisdiction or control of another State, shall make the fullest efforts to ensure that these chemical weapons are removed from its territory not later than one year after this Convention enters into force for it. If they are not removed within one year, the State Party may request the Organization and other States Parties to provide assistance in the destruction of these chemical weapons.
12. Each State Party undertakes to cooperate with other States Parties that request information or assistance on a bilateral basis or through the Technical Secretariat regarding methods and technologies for the safe and efficient destruction of chemical weapons.
13. In carrying out verification activities pursuant to this Article and Part IV (A) of the Verification Annex, the Organization shall consider measures to avoid unnecessary duplication of bilateral and multilateral agreements on verification of chemical weapons storage and their destruction among States Parties.
To this end, the Executive Council shall decide to limit verification to measures complementary to those undertaken pursuant to such a bilateral or multilateral agreement, if it considers that:
(a) Verification provisions of such an agreement are consistent with the verification provisions of this Article and Part IV (A) of the Verification Annex;
(b) Implementation of such an agreement provides for sufficient assurance of compliance with the relevant provisions of this Convention; and
(c) Parties to the bilateral or multilateral agreement keep the Organization fully informed about their verification activities.
14. If the Executive Council takes a decision pursuant to paragraph 13, the Organization shall have the right to monitor the implementation of the bilateral or multilateral agreement.
15. Nothing in paragraphs 13 and 14 shall affect the obligation of a State Party to provide declarations pursuant to Article III, this Article and Part IV (A) of the Verification Annex.
16. Each State Party shall meet the costs of destruction of chemical weapons it is obliged to destroy. It shall also meet the costs of verification of storage and destruction of these chemical weapons unless the Executive Council decides otherwise. If the Executive Council decides to limit verification measures of the Organization pursuant to paragraph 13, the costs of complementary verification and monitoring by the Organization shall be paid in accordance with the United Nations scale of assessment, as specified in Article VIII, paragraph 7.
17. The provisions of this Article and the relevant provisions of Part IV of the Verification Annex shall not, at the discretion of a State Party, apply to chemical weapons buried on its territory before 1 January 1977 and which remain buried, or which had been dumped at sea before 1 January 1985.

Article V: Chemical Weapons Production Facilities

1. The provisions of this Article and the detailed procedures for its implementation shall apply to any and all chemical weapons production facilities owned or possesed by a State Party, or that are located in any place under its jurisdiction or control.
2. Detailed procedures for the implementation of this Article are set forth in the Verification Annex.
3. All chemical weapons production facilities specified in paragraph 1 shall be subject to systematic verification through on-site inspection and monitoring with on-site instruments in accordance with Part V of the Verification Annex.
4. Each State Party shall cease immediately all activity at chemical weapons production facilities specified in paragraph 1, except activity required for closure.
5. No State Party shall construct any new chemical weapons production facilities or modify any existing facilities for the purpose of chemical weapons production or for any other activity prohibited under this Convention.
6. Each State Party shall, immediately after the declaration under Article III, paragraph 1 (c), has been submitted, provide access to chemical weapons production facilities specified in paragraph 1, for the purpose of systematic verification of the declaration through on-site inspection.
7. Each State Party shall:
(a) Close, not later than 90 days after this Convention enters into force for it, all chemical weapons production facilities specified in paragraph 1, in accordance with Part V of the Verification Annex, and give notice thereof; and

(b) Provide access to chemical weapons production facilities specified in paragraph 1, subsequent to closure, for the purpose of systematic verification through on-site inspection and monitoring with on-site instruments in order to ensure that the facility remains closed and is subsequently destroyed.

8. Each State Party shall destroy all chemical weapons production facilities specified in paragraph 1 and related facilities and equipment, pursuant to the Verification Annex and in accordance with an agreed rate and sequence of destruction (hereinafter referred to as "order of destruction"). Such destruction shall begin not later than one year after this Convention enters into force for it, and shall finish not later than 10 years after entry into force of this Convention. A State Party is not precluded from destroying such facilities at a faster rate.

9. Each State Party shall:

(a) Submit detailed plans for destruction of chemical weapons production facilities specified in paragraph 1, not later than 180 days before the destruction of each facility begins;

(b) Submit declarations annually regarding the implementation of its plans for the destruction of all chemical weapons production facilities specified in paragraph 1, not later than 90 days after the end of each annual destruction period; and

(c) Certify, not later than 30 days after the destruction process has been completed, that all chemical weapons production facilities specified in paragraph 1 have been destroyed.

10. If a State ratifies or accedes to this Convention after the IO-year period for destruction set forth in paragraph 8, it shall destroy chemical weapons production facilities specified in paragraph 1 as soon as possible. The order of destruction and procedures for stringent verification for such a State Party shall be determined by the Executive Council.

11. Each State Party. during the destruction of chemical weapons production facilities, shall assign the highest priority to ensuring the safety of people and to protecting the environment. Each State Party shall destroy these chemical weapons production facilities in accordance with its national standards for safety and emissions.

12. Chemical weapons production facilities specified in paragraph 1 may be temporarily converted for destruction of chemical weapons in accordance with Part V, paragraphs 18 to 25, of the Verification Annex. Such a converted facility must be destroyed as soon as it is no longer in use for destruction of chemical weapons but, in any case, not later than 10 years after entry into force of this Convention.

13. A State Party may request, in exceptional cases of compelling need, permission to use a chemical weapons production facility specified in paragraph 1 for purposes not prohibited under this Convention. Upon the recommendation of the Executive Council, the Conference of the States Parties shall decide whether or not to approve the request and shall establish the conditions upon which approval is contingent in accordance with Part V, Section D, of the Verification Annex.

14. The chemical weapons production facility shall be converted in such a manner that the converted facility is not more capable of being reconverted into a chemical weapons production facility than any other facility used for industrial, agricultural, research, medical, pharmaceutical or other peaceful purposes not involving chemicals listed in Schedule 1.

15. All converted facilities shall be subject to systematic verification through on-site inspection and monitoring with on-site instruments in accordance with Part V, Section D, of the Verification Annex.

16. In carrying out verification activities pursuant to this Article and Part V of the Verification Annex, the Organization shall consider measures to avoid unnecessary duplication of bilateral or multilateral agreements on verification of chemical weapons production facilities and their destruction among States Parties.

To this end, the Executive Council shall decide to limit the verification to measures complementary to those undertaken pursuant to such a bilateral or multilateral agreement, if it considers that:

(a) Verification provisions of such an agreement are consistent with the verification provisions of this Article and Part V of the Verification Annex;

(b) Implementation of the agreement provides for sufficient assurance of compliance with the relevant provisions of this Convention; and

(c) Parties to the bilateral or multilateral agreement keep the Organization fully informed about their verification activities.

17. If the Executive Council takes a decision pursuant to paragraph 16, the Organization shall have the right to monitor the implementation of the bilateral or multilateral agreement.

18. Nothing in paragraphs 16 and 17 shall affect the obligation of a State Party to make declarations pursuant to Article III, this Article and Part V of the Verification Annex.

19. Each State Party shall meet the costs of destruction of chemical weapons production facilities it is obliged to destroy. It shall also meet the costs of verification under this Article unless the Executive Council decides otherwise. If the Executive Council decides to limit verification measures of the Organization pursuant to paragraph 16, the costs of complementary verification and monitoring by the Organization shall be paid in accordance with the United Nations scale of assessment, as specified in Article VIII, paragraph 7.

Article VI: Activities Not Prohibited Under This Convention

1. Each State Party has the right, subject to the provisions of this Convention, to develop, produce, otherwise acquire, retain. transfer and use toxic chemicals and their precursors for purposes not prohibited under this Convention.

2. Each State Party shall adopt the necessary measures to ensure that toxic chemicals and their precursors are only developed, produced, otherwise acquired, retained, transferred, or used within its territory or in any other place under its jurisdiction or control for purposes not prohibited under this Convention. To this end, and in order to verify that activities are in accordance with obligations under this Convention, each State Party shall subject toxic chemicals and their precursors listed in Schedules 1, 2 and 3 of the Annex on Chemicals, facilities related to such chemicals, and other facilities as specified in the Verification Annex, that are located on its territory or in any other place under its jurisdiction or control, to verification measures as provided in the Verification Annex.

3. Each State Party shall subject chemicals listed in Schedule 1 (hereinafter referred to as "Schedule 1

chemicals") to the prohibitions on production, acquisition, retention, transfer and use as specified in Part VI of the Verification Annex. It shall subject Schedule 1 chemicals and facilities specified in Part VI of the Verification Annex to systematic verification through on-site inspection and monitoring with on-site instruments in accordance with that Part of the Verification Annex.
4. Each State Party shall subject chemicals listed in Schedule 2 (hereinafter referred to as "Schedule 2 chemicals") and facilities specified in Part VII of the Verification Annex to data monitoring and on-site verification in accordance with that Part of the Verification Annex.
5. Each State Party shall subject chemicals listed in Schedule 3 (hereinafter referred to as "Schedule 3 chemicals") and facilities specified in Part VIII of the Verification Annex to data monitoring and on-site verification in accordance with that Part of the Verification Annex.
6. Each State Party shall subject facilities specified in Part IX of the Verification Annex to data monitoring and eventual on-site verification in accordance with that Part of the Verification Annex unless decided otherwise by the Conference of the States Parties pursuant to Part IX, paragraph 22, of the Verification Annex.
7. Not later than 30 days after this Convention enters into force for it, each State Party shall make an initial declaration on relevant chemicals and facilities in accordance with the Verification Annex.
8. Each State Party shall make annual declarations regarding the relevant chemicals and facilities in accordance with the Verification Annex.
9. For the purpose of on-site verification, each State Party shall grant to the inspectors access to facilities as required in the Verification Annex.
10. In conducting verification activities, the Technical Secretariat shall avoid undue intrusion into the State Party's chemical activities for purposes not prohibited under this Convention and, in particular, abide by the provisions set forth in the Annex on the Protection of Confidential Information (hereinafter referred to as "Confidentiality Annex").
11. The provisions of this Article shall be implemented in a manner which avoids hampering the economic or technological development of States Parties and international cooperation in the field of chemical activities for purposes not prohibited under this Convention, including the international exchange of scientific and technical information and chemicals and equipment for the production, processing or use of chemicals for purposes not prohibited under this Convention.

Article VII: National Implementation Measures

General undertakings
1. Each State Party shall, in accordance with its constitutional processes, adopt the necessary measures to implement its obligations under this Convention. In particular, it shall:
   (a) Prohibit natural and legal persons anywhere on its territory or in any other place under its jurisdiction as recognized by international law from undertaking any activity prohibited to a State Party under this Convention, including enacting penal legislation with respect to such activity;
   (b) Not permit in any place under its control any activity prohibited to a State Party under this Convention; and
   (c) Extend its penal legislation enacted under subparagraph (a) to any activity prohibited to a State Party under this Convention undertaken anywhere by natural persons, possessing its nationality, in conformity with international law.
2. Each State Party shall cooperate with other States Parties and afford the appropriate form of legal assistance to facilitate the implementation of the obligations under paragraph 1.
3. Each State Party, during the implementation of its obligations under this Convention, shall assign the highest priority to ensuring the safety of people and to protecting the environment, and shall cooperate as appropriate with other States Parties in this regard.

Relations between the State Party and the Organization
4. In order to fulfill its obligations under this Convention, each State Party shall designate or establish a National Authority to serve as the national focal point for effective liaison with the Organization and other States Parties. Each State Party shall notify the Organization of its National Authority at the time that this Convention enters into force for it.
5. Each State Party shall inform the Organization of the legislative and administrative measures taken to implement this Convention.
6. Each State Party shall treat as confidential and afford special handling to information and data that it receives in confidence from the Organization in connection with the implementation of this Convention. It shall treat such information and data exclusively in connection with its rights and obligations under this Convention and in accordance with the provisions set forth in the Confidentiality Annex.
7. Each State Party undertakes to cooperate with the Organization in the exercise of all its functions and in particular to provide assistance to the Technical Secretariat.

Article VIII: The Organization

A. General Provisions
1. The States Parties to this Convention hereby establish the Organization for the Prohibition of Chemical Weapons to achieve the object and purpose of this Convention, to ensure the implementation of its provisions, including those for international verification of compliance with it, and to provide a forum for consultation and cooperation among States Parties.
2. All States Parties to this Convention shall be members of the Organization. A State Party shall not be deprived of its membership in the Organization.
3. The seat of the headquarters of the Organization shall be The Hague, Kingdom of the Netherlands.
4. There are hereby established as the organs of the Organization: the Conference of the States Parties, the Executive Council, and the Technical Secretariat.
5. The Organization shall conduct its verification activities provided for under this Convention in the least intrusive manner possible consistent with the timely and efficient accomplishment of their

objectives. It shall request only the information and data necessary to fulfill its responsibilities under this Convention. It shall take every precaution to protect the confidentiality of information on civil and military activities and facilities coming to its knowledge in the implementation of this Convention and, in particular, shall abide by the provisions set forth in the Confidentiality Annex.
6. In undertaking its verification activities the Organization shall consider measures to make use of advances in science and technology.
7. The costs of the Organization's activities shall be paid by States Parties in accordance with the United Nations scale of assessment adjusted to take into account differences in membership between the United Nations and this Organization, and subject to the provisions of Articles IV and V. Financial contributions of States Parties to the Preparatory Commission shall be deducted in an appropriate way from their contributions to the regular budget. The budget of the Organization shall comprise two separate chapters, one relating to administrative and other costs, and one relating to verification costs.
8. A member of the Organization which is in arrears in the payment of its financial contribution to the Organization shall have no vote in the Organization if the amount of its arrears equals or exceeds the amount of the contribution due from it for the preceding two full years. The Conference may, nevertheless, permit such a member to vote if it is satisfied that the failure to pay is due to conditions beyond the control of the member.

B. The Conference of the States Parties

Composition, procedures and decision-making

9. The Conference of the States Parties (hereinafter referred to as "the Conference") shall be composed of all members of this Organization. Each member shall have one representative in the Conference, who may be accompanied by alternates and advisers.
10. The first session of the Conference shall be convened by the depositary not later than 30 days after the entry into force of this Convention.
11. The Conference shall meet in regular sessions which shall be held annually unless it decides otherwise.
12. Special sessions of the Conference shall be convened:

(a) When decided by the Conference;
(b) When requested by the Executive Council;
(c) When requested by any member and supported by one third of the members; or
(d) In accordance with paragraph 22 to undertake reviews of the operation of this Convention.

Except in the case of subparagraph (d), the special session shall be convened not later than 30 days after receipt of the request by the Director-General of the Technical Secretariat, unless specified otherwise in the request.
13. The Conference shall also be convened in the form of an Amendment Conference in accordance with Article XV, paragraph 2.
14. Sessions of the Conference shall take place at the seat of the Organization unless the Conference decides otherwise.
15. The Conference shall adopt its rules of procedure. At the beginning of each regular session, it shall elect its Chairman and such other officers as may be required. They shall hold office until a new Chairman and other officers are elected at the next regular session.
16. A majority of the members of the Organization shall constitute a quorum for the Conference.
17. Each member of the Organization shall have one vote in the Conference.
18. The Conference shall take decisions on questions of procedure by a simple majority of the members present and voting. Decisions on matters of substance should be taken as far as possible by consensus. If consensus is not attainable when an issue comes up for decision, the Chairman shall defer any vote for 24 hours and during this period of deferment shall make every effort to facilitate achievement of consensus, and shall report to the Conference before the end of this period. If consensus is not possible at the end of 24 hours, the Conference shall take the decision by a two-thirds majority of members present and voting unless specified otherwise in this Convention. When the issue arises as to whether the question is one of substance or not, that question shall be treated as a matter of substance unless otherwise decided by the Conference by the majority required for decisions on matters of substance.

Powers and functions

19. The Conference shall be the principal organ of the organization. It shall consider any questions, matters or issues within the scope of this Convention, including those relating to the powers and functions of the Executive Council and the Technical Secretariat. It may make recommendations and take decisions on any questions, matters or issues related to this Convention raised by a State Party or brought to its attention by the Executive Council.
20. The Conference shall oversee the implementation of this Convention, and act in order to promote its object and purpose. The Conference shall review compliance with this Convention. It shall also oversee the activities of the Executive Council and the Technical Secretariat and may issue guidelines in accordance with this Convention to either of them in the exercise of their functions.

The Conference shall:

(a) Consider and adopt at its regular sessions the report, programme and budget of the Organization, submitted by the Executive Council, as well as consider other reports;
(b) Decide on the scale of financial contributions to be paid by States Parties in accordance with paragraph 7;
(c) Elect the members of the Executive Council;
(d) Appoint the Director-General of the Technical Secretariat (hereinafter referred to as "the Director-General");
(e) Approve the rules of procedure of the Executive Council submitted by the latter;
(f) Establish such subsidiary organs as it finds necessary for the exercise of its functions in accordance with this Convention;
(g) Foster international cooperation for peaceful purposes in the field of chemical activities;
(h) Review scientific and technological developments that could affect the operation of this Convention and, in this context, direct the Director-General to establish a Scientific Advisory Board to enable him, in the performance of his functions, to render specialized advice in areas of science

and technology relevant to this Convention, to the Conference, the Executive Council or States Parties. The Scientific Advisory Board shall be composed of independent experts appointed in accordance with terms of reference adopted by the Conference;

(i) Consider and approve at its first session any draft agreements, provisions and guidelines developed by the Preparatory Commission;

(j) Establish at its first session the voluntary fund for assistance in accordance with Article X;

(k) Take the necessary measures to ensure compliance with this Convention and to redress and remedy any situation which contravenes the provisions of this Convention, in accordance with Article XII.

22. The Conference shall not later than one year after the expiry of the fifth and the tenth year after the entry into force of this Convention, and at such other times within that time period as may be decided upon, convene in special sessions to undertake reviews of the operation of this Convention. Such reviews shall take into account any relevant scientific and technological developments. At intervals of five years thereafter, unless otherwise decided upon, further sessions of the Conference shall be convened with the same objective.

C. The Executive Council

Composition, procedure and decision-making

23. The Executive Council shall consist of 41 members. Each State Party shall have the right, in accordance with the principle of rotation, to serve on the Executive Council. The members of the Executive Council shall be elected by the Conference for a term of two years. In order to ensure the effective functioning of this Convention, due regard being specially paid to equitable geographical distribution, to the importance of chemical industry, as well as to political and security interests, the Executive Council shall be composed as follows:

(a) Nine States Parties from Africa to be designated by States Parties located in this region. As a basis for this designation it is understood that, out of these nine States Parties, three members shall, as a rule, be the States Parties with the most significant national chemical industry in the region as determined by internationally reported and published data; in addition, the regional group shall agree also to take into account other regional factors in designating these three members;

(b) Nine States Parties from Asia to be designated by States Parties located in this region. As a basis for this designation it is understood that, out of these nine States Parties, four members shall, as a rule, be the States Parties with the most significant national chemical industry in the region as determined by internationally reported and published data; in addition, the regional group shall agree also to take into account other regional factors in designating these four members;

(c) Five States Parties from Eastern Europe to be designated by States Parties located in this region. As a basis for this designation it is understood that, out of these five States Parties, one member shall, as a rule, be the State Party with the most significant national chemical industry in the region as determined by internationally reported and published data; in addition, the regional group shall agree also to take into account other regional factors in designating this one member;

(d) Seven States Parties from Latin America and the Caribbean to be designated by States Parties located in this region. As a basis for this designation it is understood that, out of these seven States Parties, three members shall, as a rule, be the States Parties with the most significant national chemical industry in the region as determined by internationally reported and published data; in addition, the regional group shall agree also to take into account other regional factors in designating these three members;

(e) Ten States Parties from among Western European and Other States to be designated by States Parties located in this region. As a basis for this designation it is understood that, out of these ten States Parties, five members shall, as a rule, be the States Parties with the most significant national chemical industry in the region as determined by internationally reported and published data; in addition, the regional group shall agree also to take into account other regional factors in designating these five members;

(f) One further State Party to be designated consecutively by States Parties located in the regions of Asia and Latin America and the Caribbean. As a basis for this designation it is understood that this State Party shall be a rotating member from these regions.

24. For the first election of the Executive Council 20 members shall be elected for a term of one year, due regard being paid to the established numerical proportions as described in paragraph 23.

25. After the full implementation of Articles IV and V the Conference may, upon the request of a majority of the members of the Executive Council, review the composition of the Executive Council taking into account developments related to the principles specified in paragraph 23 that are governing its composition.

26. The Executive Council shall elaborate its rules of procedure and submit them to the Conference for approval.

27. The Executive Council shall elect its Chairman from among its members.

28. The Executive Council shall meet for regular sessions. Between regular sessions it shall meet as often as may be required for the fulfillment of its powers and functions.

29. Each member of the Executive Council shall have one vote. Unless otherwise specified in this Convention, the Executive Council shall take decisions on matters of substance by a two-thirds majority of all its members. The Executive Council shall take decisions on questions of procedure by a simple majority of all its members. When the issue arises as to whether the question is one of substance or not, that question shall be treated as a matter of substance unless otherwise decided by the Executive Council by the majority required for decisions on matters of substance.

Powers and functions

30. The Executive Council shall be the executive organ of the Organization. It shall be responsible to the Conference. The Executive Council shall carry out the powers and functions entrusted to it under this Convention, as well as those functions delegated to it by the Conference. In *so* doing, it shall act in conformity with the recommendations, decisions and guidelines of the Conference and assure their proper and continuous implementation.

31. The Executive Council shall promote the effective implementation of, and compliance with, this Convention. It shall supervise the activities of the Technical Secretariat, cooperate with the National Authority of each State Party and facilitate consultations and cooperation among States Parties at their request.
32. The Executive Council shall:
(a) Consider and submit to the Conference the draft programme and budget of the Organization;
(b) Consider and submit to the Conference the draft report of the Organization on the implementation of this Convention, the report on the performance of its own activities and such special reports as it deems necessary or which the Conference may request;
(c) Make arrangements for the sessions of the Conference including the preparation of the draft agenda.
33. The Executive Council may request the convening of a special session of the Conference.
34. The Executive Council shall:
(a) Conclude agreements or arrangements with States and international organizations on behalf of the Organization, subject to prior approval by the Conference;
(b) Conclude agreements with States Parties on behalf of the Organization in connection with Article **X** and supervise the voluntary fund referred to in Article **X;**
(c) Approve agreements or arrangements relating to the implementation of verification activities, negotiated by the Technical Secretariat with States Parties.
35. The Executive Council shall consider any issue or matter within its competence affecting this Convention and its implementation, including concerns regarding compliance, and cases of non-compliance, and, as appropriate, inform States Parties and bring the issue or matter to the attention of the Conference.
36. In its consideration of doubts or concerns regarding compliance and cases of non-compliance, including, ***inter** alia,* abuse of the rights provided for under this Convention, the Executive Council shall consult with the States Parties involved and, as appropriate, request the State Party to take measures to redress the situation within a specified time. To the extent that the Executive Council considers further action to be necessary, it shall take, ***inter** alia,* one or more of the following measures:
(a) Inform all States Parties of the issue or matter;
(b) Bring the issue or matter to the attention of the Conference;
(c) Make recommendations to the Conference regarding measures to redress the situation and to ensure compliance.
The Executive Council shall, in cases of particular gravity and urgency, bring the issue or matter, including relevant information and conclusions, directly to the attention of the United Nations General Assembly and the United Nations Security Council. It shall at the same time inform all States Parties of this step.

D. The Technical Secretariat
37. The Technical Secretariat shall assist the Conference and the Executive Council in the performance of their functions. The Technical Secretariat shall carry out the verification measures provided for in this Convention. It shall carry out the other functions entrusted to it under this Convention as well as those functions delegated to it by the Conference and the Executive Council.
38. The Technical Secretariat shall:
(a) Prepare and submit to the Executive Council the draft programme and budget of the Organization;
(b) Prepare and submit to the Executive Council the draft report of the Organization on the implementation of this Convention and such other reports as the Conference or the Executive Council may request;
(c) Provide administrative and technical support to the Conference, the Executive Council and subsidiary organs;
(d) Address and receive communications on behalf of the Organization to and from States Parties on matters pertaining to the implementation of this Convention;
(e) Provide technical assistance and technical evaluation to States Parties in the implementation of the provisions of this Convention, including evaluation of scheduled and unscheduled chemicals.
39. The Technical Secretariat shall:
(a) Negotiate agreements or arrangements relating to the implementation of verification activities with States Parties, subject to approval by the Executive Council;
(b) Not later than 180 days after entry into force of this Convention, coordinate the establishment and maintenance of permanent stockpiles of emergency and humanitarian assistance by States Parties in accordance with Article X, paragraphs 7 (b) and (c). The Technical Secretariat may inspect the items maintained for serviceability. Lists of items to be stockpiled shall be considered and approved by the Conference pursuant to paragraph 21 (i) above;
(c) Administer the voluntary fund referred to in Article **X,** compile declarations made by the States Parties and register, when requested, bilateral agreements concluded between States Parties or between a State Party and the Organization for the purposes of Article **X.**
40. The Technical Secretariat shall inform the Executive Council of any problem that has arisen with regard to the discharge of its functions, including doubts, ambiguities or uncertainties about compliance with this Convention that have come to its notice in the performance of its verification activities and that it has been unable to resolve or clarify through its consultations with the State Party concerned.
41. The Technical Secretariat shall comprise a Director-General, who shall be its head and chief administrative officer, inspectors and such scientific, technical and other personnel as may be required.
42. The Inspectorate shall be a unit of the Technical Secretariat and shall act under the supervision of the Director-General.
43. The Director-General shall be appointed by the Conference upon the recommendation of the Executive Council for a term of four years, renewable for one further term, but not thereafter.
44. The Director-General shall be responsible to the Conference and the Executive Council for the appointment of the staff and the organization and functioning of the Technical Secretariat. The paramount consideration in the employment of the staff and in the determination of the conditions of

service shall be the necessity of securing the highest standards of efficiency, competence and integrity. Only citizens of States Parties shall serve as the Director-General, as inspectors or as other members of the professional and clerical staff. Due regard shall be paid to the importance of recruiting the staff on as wide a geographical basis as possible. Recruitment shall be guided by the principle that the staff shall be kept to a minimum necessary for the proper discharge of the responsibilities of the Technical Secretariat.

45. The Director-General shall be responsible for the organization and functioning of the Scientific Advisory Board referred to in paragraph 21 (h). The Director-General shall, in consultation with States Parties, appoint members of the Scientific Advisory Board, who shall serve in their individual capacity. The members of the Board shall be appointed on the basis of their expertise in the particular scientific fields relevant to the implementation of this Convention. The Director-General may also, as appropriate, in consultation with members of the Board, establish temporary working groups of scientific experts to provide recommendations on specific issues. In regard to the above, States Parties may submit lists of experts to the Director-General.

46. In the performance of their duties, the Dirctor-General, the inspectors and the other members of the staff shall not see or receive instructions from any Government or from any other source external to the Organization. They shall refrain from any action that might reflect on their positions as international officers responsible only to the Conference and the Executive Council.

47. Each State Party shall respect the exclusively international character of the responsibilities of the Director-General, the inspectors and the other members of the staff and not seek to influence them in the discharge of their responsibilities.

E. Privileges and Immunities

48. The Organization shall enjoy on the territory and in any other place under the jurisdiction or control of a State Party such legal capacity and such privileges and immunities as are necessary for the exercise of its functions.

49. Delegates **of** States Parties, together with their alternates and advisers, representatives appointed to the Executive Council together with their alternates and advisers, the Director-General and the staff of the Organization shall enjoy such privileges and immunities as are necessary in the independent exercise of their functions in connection with the Organization.

50. The legal capacity, privileges, and immunities referred to in this Article shall be defined in agreements between the Organization and the States Parties as well as in an agreement between the Organization and the State in which the headquarters of the Organization is seated. These agreements shall be considered and approved by the Conference pursuant to paragraph 21 (i).

51. Notwithstanding paragraphs 48 and 49, the privileges and immunities enjoyed by the Director-General and the staff of the Technical Secretariat during the conduct of verification activities shall be those set forth in Part II, Section B, of the Verification Annex.

Article IX: Consultations, Cooperation and Fact-Finding

1. States Parties shall consult and cooperate, directly among themselves, or through the Organization or other appropriate international procedures, including procedures within the framework of the United Nations and in accordance with its Charter, on any matter which may be raised relating to the object and purpose, or the implementation of the provisions, of this Convention.

2. Without prejudice to the right of any State Party to request a challenge inspection, States Parties should, whenever possible, first make every effort to clarify and resolve, through exchange of information and consultations among themselves, any matter which may cause doubt about compliance with this Convention, or which gives rise to concerns about a related matter which may be considered ambiguous. A State Party which receives a request from another State Party for clarification of any matter which the requesting State Party believes causes such a doubt or concern shall provide the requesting State Party as soon as possible, but in any case not later than 10 days after the request, with information sufficient to answer the doubt or concern raised along with an explanation of how the information provided resolves the matter. Nothing in this Convention shall affect the right of any two or more States Parties to arrange by mutual consent for inspections or any other procedures among themselves to clarify and resolve any matter which may cause doubt about compliance or gives rise to a concern about a related matter which may be considered ambiguous. Such arrangements shall not affect the rights and obligations of any State Party under other provisions of this Convention.

Procedure for requesting clarification

3. A State Party shall have the right to request the Executive Council to assist in clarifying any situation which may be considered ambiguous or which gives rise to a concern about the possible non-compliance of another State Party with this Convention. The Executive Council shall provide appropriate information in its possession relevant to such a concern.

4. A State Party shall have the right to request the Executive Council to obtain clarification from another State Party on any situation which may be considered ambiguous or which gives rise to a concern about its possible non-compliance with this Convention. In such a case, the following shall apply:

(a) The Executive Council shall forward the request for clarification to the State Party concerned through the Director-General not later than 24 hours after its receipt;

(b) The requested State Party shall provide the clarification to the Executive Council as soon as possible, but in any case not later than 10 days after the receipt of the request;

(c) The Executive Council shall take note of the clarification and forward it to the requesting State Party not later than 24 hours after its receipt;

(d) If the requesting State Party deems the clarification to be inadequate, it shall have the right to request the Executive Council to obtain from the requested State Party further clarification;

(e) For the purpose of obtaining further clarification requested under subparagraph (d), the Executive Council may call on the Director-General to establish a group of experts from the Technical Secretariat, or if appropriate staff are not available in the Technical Secretariat, from

elsewhere, to examine all available information and data relevant to the situation causing the concern. The group of experts shall submit a factual report to the Executive Council on its findings;

(f) If the requesting State Party considers the clarification obtained under subparagraphs (d) and (e) to be unsatisfactory, it shall have the right to request a special session of the Executive Council in which States Parties involved that are not members of the Executive Council shall be entitled to take part. In such a special session, the Executive Council shall consider the matter and may recommend any measure it deems appropriate to resolve the situation.

5. A State Party shall also have the right to request the Executive Council to clarify any situation which has been considered ambiguous or has given rise to a concern about its possible non-compliance with this Convention. The Executive Council shall respond by providing such assistance as appropriate.

6. The Executive Council shall inform the States Parties about any request for clarification provided in this Article.

7. If the doubt or concern of a State Party about a possible non-compliance has not been resolved within 60 days after the submission of the request for clarification to the Executive Council, or it believes its doubts warrant urgent consideration, notwithstanding its right to request a challenge inspection, it may request a special session of the Conference in accordance with Article VIII, paragraph 12 (c). At such a special session, the Conference shall consider the matter and may recommend any measure it deems appropriate to resolve the situation.

Procedures for Challenge Inspections

8. Each State Party has the right to request an on-site challenge inspection of any facility or location in the territory or in any other place under the jurisdiction or control of any other State Party for the sole purpose of clarifying and resolving any questions concerning possible non-compliance with the provisions of this Convention, and to have this inspection conducted anywhere without delay by an inspection team designated by the Director-General and in accordance with the Verification Annex.

9. Each State Party is under the obligation to keep the inspection request within the scope of this Convention and to provide in the inspection request all appropriate information on the basis of which a concern has arisen regarding possible non-compliance with this Convention as specified in the Verification Annex. Each State Party shall refrain from unfounded inspection requests, care being taken to avoid abuse. The challenge inspection shall be carried out for the sole purpose of determining facts relating to the possible non-compliance.

10. For the purpose of verifying compliance with the provisions of this Convention, each State Party shall permit the Technical Secretariat to conduct the on-site challenge inspection pursuant to paragraph 8.

11. Pursuant to a request for a challenge inspection of a facility or location, and in accordance with the procedures provided for in the Verification Annex, the inspected State Party shall have:

(a) The right and the obligation to make evey reasonable effort to demonstrate its compliance with this Convention and, to this end, to enable the inspection team to fulfill its mandate;

(b) The obligation to provide access within the requested site for the sole purpose of establishing facts relevant to the concern regarding possible non-compliance; and

(c) The right to take measures to protect sensitive installations, and to prevent disclosure of confidential information and data, not related to this Convention.

12. With regard to an observer, the following shall apply:

(a) The requesting State Party may, subject to the agreement of the inspected State Party, send a representative who may be a national either of the requesting State Party or of a third State Party, to observe the conduct of the challenge inspection.

(b) The inspected State Party shall then grant access to the observer in accordance with the Verification Annex.

(c) The inspected State Party shall, as a rule, accept the proposed observer, but if the inspected State Party exercises a refusal, that fact shall be recorded in the final report.

13. The requesting State Party shall present an inspection request for an on-site challenge inspection to the Executive Council and at the same time to the Director-General for immediate processing.

14. The Director-General shall immediately ascertain that the inspection request meets the requirements specified in Part X, paragraph 4, of the Verification Annex, and, if necessary, assist the requesting State Party in filing the inspection request accordingly. When the inspection request fulfills the requirements, preparations for the challenge inspection shall begin.

15. The Director-General shall transmit the inspection request to the inspected State Party not less than 12 hours before the planned arrival of the inspection team at the point of entry.

16. After having received the inspection request, the Executive Council shall take cognizance of the Director-General's actions on the request and shall keep the case under its consideration throughout the inspection procedure. However, its deliberations shall not delay the inspection process.

17. The Executive Council may, not later than 12 hours after having received the inspection request, decide by a three-quarter majority of all its members against carrying out the challenge inspection, if it considers the inspection request to be frivolous, abusive or clearly beyond the scope of this Convention as described in paragraph ***8.*** Neither the requesting nor the inspected State Party shall participate in such a decision. If the Executive Council decides against the challenge inspection, preparations shall be stopped, no further action on the inspection request shall be taken, and the States Parties concerned shall be informed accordingly.

18. The Director-General shall issue an inspection mandate for the conduct of the challenge inspection. The inspection mandate shall be the inspection request referred to in paragraphs 8 and 9 put into operational terms, and shall conform with the inspection request.

19. The challenge inspection shall be conducted in accordance with Part Xor, in the case of alleged use, in accordance with Part XI of the Verification Annex. The inspection team shall be guided by the principle of conducting the challenge inspection in the least intrusive manner possible, consistent with the effective and timely accomplishment of its mission.

20. The inspected State Party shall assist the inspection team throughout the challenge inspection and facilitate its task. If the inspected State Party proposes, pursuant to Part X, Section C, of the Verification Annex, arrangements to demonstrate compliance with this Convention, alternative to full and comprehensive access, it shall make every reasonable effort, through consultations with the inspection

team, to reach agreement on the modalities for establishing the facts with the aim of demonstrating its compliance.

21. The final report shall contain the factual findings as well as an assessment by the inspection team of the degree and nature of access and cooperation granted for the satisfactory implementation of the challenge inspection. The Director-General shall promptly transmit the final report of the inspection team to the requesting State Party, to the inspected State Party, to the Executive Council and to all other States Parties. The Director-General shall further transmit promptly to the Executive Council the assessments of the requesting and of the inspected States Parties, as well as the views of other States Parties which may be conveyed to the Director-General for that purpose, and then provide them to all States Parties.

22. The Executive Council shall, in accordance with its powers and functions, review the final report of the inspection team as soon as it is presented, and address any concerns as to:

(a) Whether any non-compliance has occurred;

(b) Whether the request had been within the scope of this Convention; and

(c) Whether the right to request a challenge inspection had been abused.

23. If the Executive Council reaches the conclusion, in keeping with its powers and functions, that further action may be necessary with regard to paragraph 22, it shall take the appropriate measures to redress the situation and to ensure compliance with this Convention, including specific recommendations to the Conference. In the case of abuse, the Executive Council shall examine whether the requesting State Party should bear any of the financial implications of the challenge inspection.

24. The requesting State Party and the inspected State Party shall have the right to participate in the review process. The Executive Council shall inform the States Parties and the next session of the Conference of the outcome of the process.

25. If the Executive Council has made specific recommendations to the Conference, the Conference shall consider action in accordance with Article XII.

Article X: Assistance and Protection Against Chemical Weapons

1. For the purposes of this Article, "Assistance" means the coordination and delivery to States Parties of protection against chemical weapons, including, *inter alia,* the following: detection equipment and alarm systems; protective equipment; decontamination equipment and decontaminants; medical antidotes and treatments; and advice on any of these protective measures.

2. Nothing in this Convention shall be interpreted as impeding the right of any State Party to conduct research into, develop, produce, acquire, transfer or use means of protection against chemical weapons, for purposes not prohibited under this Convention.

3. Each State Party undertakes to facilitate, and shall have the right to participate in, the fullest possible exchange of equipment, material and scientific and technological information concerning means of protection against chemical weapons.

4. For the purposes of increasing the transparency of national programmes related to protective purposes, each State Party shall provide annually to the Technical Secretariat information on its programme, in accordance with procedures to be considered and approved by the Conference pursuant to Article VIII, paragraph 21 (i).

5. The Technical Secretariat shall establish, not later than 180 days after entry into force of this Convention and maintain, for the use of any requesting State Party, a data bank containing freely available information concerning various means of protection against chemical weapons as well as such information as may be provided by States Parties.

The Technical Secretariat shall also, within the resources available to it, and at the request of a State Party, provide expert advice and assist the State Party in identifying how its programmes for the development and improvement of a protective capacity against chemical weapons could be implemented.

6. Nothing in this Convention shall be interpreted as impeding the right of States Parties to request and provide assistance bilaterally and to conclude individual agreements with other States Parties concerning the emergency procurement of assistance.

7. Each State Party undertakes to provide assistance through the Organization and to this end to elect to take one or more of the following measures:

(a) To contribute to the voluntary fund for assistance to be established by the Conference at its first session;

(b) To conclude, if possible not later than 180 days after this Convention enters into force for it, agreements with the Organization concerning the procurement, upon demand, of assistance;

(c) To declare, not later than 180 days after this Convention enters into force for it, the kind of assistance it might provide in response to an appeal by the Organization. If, however, a State Party subsequently is unable to provide the assistance envisaged in its declaration, it is still under the obligation to provide assistance in accordance with this paragraph.

8. Each State Party has the right to request and, subject to the procedures set forth in paragraphs 9, 10 and 11, to receive assistance and protection against the use or threat of use of chemical weapons if it considers that:

(a) Chemical weapons have been used against it;

(b) Riot control agents have been used against it as a method of warfare; or

(c) It is threatened by actions or activities of any State that are prohibited for States Parties by Article I.

9. The request, substantiated by relevant information, shall be submitted to the Director-General, who shall transmit it immediately to the Executive Council and to all States Parties. The Director-General shall immediately forward the request to States Parties which have volunteered, in accordance with paragraphs 7 (b) and (c), to dispatch emergency assistance in case of use of chemical weapons or use of riot control agents as a method of warfare, or humanitarian assistance in case of serious threat of use of chemical weapons or serious threat of use of riot control agents as a method of warfare to the State Party concerned not later than 12 hours after receipt of the request. The Director-General shall initiate,

not later that 24 hours after receipt of the request, an investigation in order to provide foundation for further action. He shall complete the investigation within 72 hours and forward a report to the Executive Council. If additional time is required for completion of the investigation, an interim report shall be submitted within the same time-frame. The additional time required for investigation shall not exceed 72 hours. It may, however, be further extended by similar periods. Reports at the end of each additional period shall be submitted to the Executive Council. The investigation shall, as appropriate and in conformity with the request and the information accompanying the request, establish relevant facts related to the request as well as the type and scope of supplementary assistance and protection needed.

10. The Executive Council shall meet not later than 24 hours after receiving an investigation report to consider the situation and shall take a decision by simple majority within the following 24 hours on whether to instruct the Technical Secretariat to provide supplementary assistance. The Technical Secretariat shall immediately transmit to all States Parties and relevant international organizations the investigation report and the decision taken by the Executive Council. When *so* decided by the Executive Council, the Director-General shall provide assistance immediately. For this purpose, the Director-General may cooperate with the requesting State Party, other States Parties and relevant international organizations. The States Parties shall make the fullest possible efforts to provide assistance.

11. If the information available from the ongoing investigation or other reliable sources would give sufficient proof that there are victims of use of chemical weapons and immediate action is indispensable, the Director-General shall notify all States Parties and shall take emergency measures of assistance, using the resources the Conference has placed at his disposal for such contingencies. The Director-General shall keep the Executive Council informed of actions undertaken pursuant to this paragraph.

Article XI: Economic and Technological Development

1. The provisions of this Convention shall be implemented in a manner which avoids hampering the economic or technological development of States Parties, and international cooperation in the field of chemical activities for purposes not prohibited under this Convention including the international exchange of scientific and technical information and chemicals and equipment for the production, processing or use of chemicals for purposes not prohibited under this Convention.

2. Subject to the provisions of this Convention and without prejudice to the principles and applicable rules of international law, the States Parties shall:

(a) Have the right, individually or collectively, to conduct research with, to develop, produce, acquire, retain, transfer, and use chemicals;

(b) Undertake to facilitate, and have the right to participate in, the fullest possible exchange of chemicals, equipment and scientific and technical information relating to the development and application of chemistry for purposes not prohibited under this Convention;

(c) Not maintain among themselves any restrictions, including those in any international agreements, incompatible with the obligations undertaken under this Convention, which would restrict or impede trade and the development and promotion of scientific and technological knowledge in the field of chemistry for industrial, agricultural, research, medical, pharmaceutical or other peaceful purposes;

(d) Not use this Convention as grounds for applying any measures other than those provided for, or permitted, under this Convention nor use any other international agreement for pursuing an objective inconsistent with this Convention;

(e) Undertake to review their existing national regulations in the field of trade in chemicals in order to render them consistent with the object and purpose of this Convention.

Article XII: Measures to Redress a Situation and to Ensure Compliance, Including Sanctions

1. The Conference shall take the necessary measures, as set forth in paragraphs 2, 3 and 4, to ensure compliance with this Convention and to redress and remedy any situation which contravenes the provisions of this Convention. In considering action pursuant to this paragraph, the Conference shall take into account all information and recommendations on the issues submitted by the Executive Council.

2. In cases where a State Party has been requested by the Executive Council to take measures to redress a situation raising problems with regard to its compliance, and where the State Party fails to fulfill the request within the specified time, the Conference may, ***inter alia,*** upon the recommendation of the Executive Council, restrict or suspend the State Party's rights and privileges under this Convention until it undertakes the necessary action to conform with its obligations under this Convention.

3. In cases where serious damage to the object and purpose of this Convention may result from activities prohibited under this Convention, in particular by Article I, the Conference may recommend collective measures to States Parties in conformity with international law.

4. The Conference shall in cases of particular gravity, bring the issue, including relevant information and conclusions, to the attention of the United Nations General Assembly and the United Nations Security Council.

Article XIII: Relation to Other International Agreements

Nothing in this Convention shall be interpreted as in any way limiting or detracting from the obligations assumed by any State under the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, and under the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, signed at London, Moscow and Washington on 10 April 1972.

Article XIV: Settlement of Disputes

1. Disputes that may arise concerning the application or the interpretation of this Convention shall be settled in accordance with the relevant provisions of this Convention and in conformity with the provisions of the Charter of the United Nations.
2. When a dispute arises between two or more States Parties, or between one or more States Parties and the Organization, relating to the interpretation or application of this Convention, the parties concerned shall consult together with a view to the expeditious settlement of the dispute by negotiation or by other peaceful means of the parties' choice, including recourse to appropriate organs of this Convention and, by mutual consent, referral to the International Court of Justice in conformity with the Statute of the Court. The States Parties involved shall keep the Executive Council informed of actions being taken.
3. The Executive Council may contribute to the settlement of a dispute by whatever means it deems appropriate, including offering its good offices, calling upon the States Parties to a dispute to start the settlement process of their choice and recommending a time-limit for any agreed procedure.
4. The Conference shall consider questions related to disputes raised by States Parties or brought to its attention by the Executive Council. The Conference shall, as it finds necessary, establish or entrust organs with tasks related to the settlement of these disputes in conformity with Article VIII, paragraph 21 (f).
5. The Conference and the Executive Council are separately empowered, subject to authorization from the General Assembly of the United Nations, to request the International Court of Justice to give an advisory opinion on any legal question arising within the scope of the activities of the Organization. An agreement between the Organization and the United Nations shall be concluded for this purpose in accordance with Article VIII, paragraph 34 (a).
6. This Article is without prejudice to Article IX or to the provisions on measures to redress a situation and to ensure compliance, including sanctions.

Article XV: Amendments

1. Any State Party may propose amendments to this Convention. Any State Party may also propose changes, as specified in paragraph 4, to the Annexes of this Convention. Proposals for amendments shall be subject to the procedures in paragraphs 2 and 3. Proposals for changes, as specified in paragraph 4, shall be subject to the procedures in paragraph 5.
2. The test of a proposed amendment shall be submitted to the Director-General for circulation to all States Parties and to the Depositary. The proposed amendment shall be considered only by an Amendment Conference. Such an Amendment Conference shall be convened if one third or more of the States Parties notify the Director-General not later than 30 days after its circulation that they support further consideration of the proposal. The Amendment Conference shall be held immediately following a regular session of the Conference unless the requesting States Parties ask for an earlier meeting. In no case shall an Amendment Conference be held less than 60 days after the circulation of the proposed amendment.
3. Amendments shall enter into force for all States Parties 30 days after deposit of the instruments of ratification or acceptance by all the States Parties referred to under subparagraph (b) below:

(a) When adopted by the Amendment Conference by a positive vote of a majority of all States Parties with no State Party casting a negative vote; and

(b) Ratified or accepted by all those States Parties casting a positive vote at the Amendment Conference.

4. In order to ensure the viability and the effectiveness of this Convention, provisions in the Annexes shall be subject to changes in accordance with paragraph 5, if proposed changes are related only to matters of an administrative or technical nature. All changes to the Annex on Chemicals shall be made in accordance with paragraph 5. Sections A and C of the Confidentiality Annex, Part X of the Verification Annex, and those definitions in Part I of the Verification Annex which relate exclusively to challenge inspections, shall not be subject to changes in accordance with paragraph 5.
5. Proposed changes referred to in paragraph 4 shall be made in accordance with the following procedures:

(a) The test of the proposed changes shall be transmitted together with the necessary information to the Director-General. Additional information for the evaluation of the proposal may be provided by any State Party and the Director-General. The Director-General shall promptly communicate any such proposals and information to all States Parties, the Executive Council and the Depositary;

(b) Not later than *60* days after its receipt, the Director-General shall evaluate the proposal to determine all its possible consequences for the provisions of this Convention and its implementation and shall communicate any such information to all States Parties and the Executive Council;

(c) The Executive Council shall examine the proposal in the light of all information available to it, including whether the proposal fulfills the requirements of paragraph 4. Not later than 90 days after its receipt, the Executive Council shall notify its recommendation, with appropriate explanations, to all States Parties for consideration. States Parties shall acknowledge receipt within 10 days;

(d) If the Executive Council recommends to all States Parties that the proposal be adopted, it shall be considered approved if no State Party objects to it within 90 days after receipt of the recommendation. If the Executive Council recommends that the proposal be rejected, it shall be considered rejected if no State Party objects to the rejection within 90 days after receipt of the recommendation.

(e) If a recommendation of the Executive Council does not meet with the acceptance required under subparagraph (d), a decision on the proposal, including whether it fulfills the requirements of paragraph 4, shall be taken as a matter of substance by the Conference at its next session;

(f) The Director-General shall notify all States Parties and the Depositary of any decision under this paragraph;

(g) Changes approved under this procedure shall enter into force for all States Parties 180 days after the date of notification by the Director-General of their approval unless another time period is recommended by the Executive Council or decided by the Conference.

Article XVI: Duration and Withdrawal

1. This Convention shall be of unlimited duration.
2. Each State Party shall, in exercising its national sovereignty, have the right to withdraw from this Convention if it decides that extraordinary events, related to the subject matter of this Convention, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal 90 days in advance to all other States Parties, the Executive Council, the Depositary and the United Nations Security Council. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.
3. The withdrawal of a State Party from this Convention shall not in any way affect the duty of States to continue fulfilling the obligations assumed under any relevant rules of international law, particularly the Geneva Protocol of 1925.

Article XVII: Status of the Annexes

The Annexes form an integral part of this Convention. Any reference to this Convention includes the Annexes.

Article XVIII: Signature

This Convention shall be open for signature for all States before its entry into force.

Article XIX: Ratification

This Convention shall be subject to ratification by States Signatories according to their respective constitutional processes.

Article XX: Accession

Any State which does not sign this Convention before its entry into force may accede to it at any time thereafter.

Article XXI: Entry Into Force

1. This Convention shall enter into force 180 days after the date of the deposit of the 65th instrument of ratification, but in no case earlier than two years after its opening for signature.
2. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Convention, it shall enter into force on the 30th day following the date of deposit of their instrument of ratification or accession.

Article XXII: Reservations

The Articles of this Convention shall not be subject to reservations. The Annexes of this Convention shall not be subject to reservations incompatible with its object and purpose.

Article XXIII: Depositary

The Secretary-General of the United Nations is hereby designated as the Depositary of this Convention and shall, ***inter alia:***

(a) Promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or accession and the date of the entry into force of this Convention, and of the receipt of other notices;

(b) Transmit duly certified copies of this Convention to the Governments of all signatory and acceding States; and

(c) Register this Convention pursuant to Article 102 of the Charter of the United Nations.

Article XXIV: Authentic Texts

This Convention, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

IN WITNESS WHEREOF the undersigned, being duly authorized to that effect, have signed this Convention.

Chairman's Draft Text of the Comprehensive Test Ban Treaty

28 June 1996

Preamble

The States Parties to this Treaty (hereinafter referred to as "the States Parties"),

Welcoming the international agreements and other positive measures of recent years in the field of nuclear disarmament, including reductions in arsenals of nuclear weapons, as well as in the field of the prevention of nuclear proliferation in all its aspects,

Underlining the importance of the full and prompt implementation of such agreements and measures,

Convinced that the present international situation provides an opportunity to take further effective measures towards nuclear disarmament and against the proliferation of nuclear weapons in all its aspects, and declaring their intention to take such measures,

Stressing therefore the need for continued systematic and progressive efforts to reduce nuclear weapons globally, with the ultimate goal of eliminating those weapons, and of general and complete disarmament under strict and effective international control,

Recognizing that the cessation of all nuclear weapon test explosions and all other nuclear explosions, by constraining the development and qualitative improvement of nuclear weapons and ending the development of advanced new types of nuclear weapons, constitutes an effective measure of nuclear disarmament and non-proliferation in all its aspects,

Further recognizing that an end to all such nuclear explosions will thus constitute a meaningful step in the realization of a systematic process to achieve nuclear disarmament,

Convinced that the most effective way to achieve an end to nuclear testing is through the conclusion of a universal and internationally and effectively verifiable comprehensive nuclear test-ban treaty, which has long been one of the highest priority objectives of the international community in the field of disarmament and non-proliferation,

Noting the aspirations expressed by the Parties to the 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time,

Noting also the views expressed that this Treaty could contribute to the protection of the environment,

Affirming the purpose of attracting the adherence of all States to this Treaty and its objective to contribute effectively to the prevention of the proliferation of nuclear weapons in all its aspects, to the process of nuclear disarmament and therefore to the enhancement of international peace and security,

Have agreed as follows:

Article I: Basic Obligations

1. Each State Party undertakes not to carry out any nuclear weapon test explosion or any other nuclear explosion, and to prohibit and prevent any such nuclear explosion at any place under its jurisdiction or control.
2. Each State Party undertakes, furthermore, to refrain from causing, encouraging, or in any way participating in the carrying out of any nuclear weapon test explosion or any other nuclear explosion.

Article II: The Organization

A. General Provisions

1. The States Parties hereby establish the Comprehensive Nuclear Test-Ban Treaty Organization (hereinafter referred to as "the organization") to achieve the object and purpose of this Treaty, to ensure the implementation of its provisions, including those for international verification of compliance with it, and to provide a forum for consultation and co-operation among States Parties.
2. All States Parties shall be members of the Organization. A State Party shall not be deprived of its membership in the Organization.
3. The seat of the Organization shall be Vienna, Republic of Austria.
4. There are hereby established as organs of the Organization: the Conference of the States Parties, the Executive Council and the Technical Secretariat, which shall include the International Data Center.
5. Each State Party shall co-operate with the Organization in the exercise of its functions in accordance with this Treaty. States Parties shall consult, directly among themselves, or through the Organization or other appropriate international procedures, including procedures within the framework of the United Nations and in accordance with its Charter, on any matter which may be raised relating to the object and purpose, or the implementation of the provisions, of this Treaty.
6. The Organization shall conduct its verification activities provided for under this Treaty in the least intrusive manner possible consistent with the timely and efficient accomplishment of their objectives. It shall request only the information and data necessary to fulfill its responsibilities under this Treaty. It shall take every precaution to protect the confidentiality of information on civil and military activities and facilities coming to its knowledge in the implementation of this Treaty and, in particular, shall abide by the confidentiality provisions set forth in this Treaty.
7. Each State Party shall treat as confidential and afford special handling to information and data that it receives in confidence from the Organization in connection with the implementation of this Treaty. It shall treat such information and data exclusively in connection with its rights and obligations under this Treaty.
8. The Organization, as an independent body, shall seek to utilize existing expertise and facilities, as appropriate, and to maximize cost efficiencies, through co-operative arrangements with other international organizations such as the International Atomic Energy Agency. Such arrangements,

excluding those of a minor and normal commercial and contractual nature, shall be set out in agreements to be submitted to the Conference of the States Parties for approval.
9. The costs of the activities of the Organization shall be met annually by the States Parties in accordance with the United Nations scale of assessments adjusted to take into account differences in membership between the United Nations and the Organization.
10. Financial contributions of States Parties to the Preparatory Commission shall be deducted in an appropriate way from their contributions to the regular budget.
11. A member of the Organization which is in arrears in the payment of its assessed contribution to the Organization shall have no vote in the Organization if the amount of its arrears equals or exceeds the amount of the contribution due from it for the preceding two full years. The Conference of the States Parties may, nevertheless, permit such a member to vote if it is satisfied that the failure to pay is due to conditions beyond the control of the member.

B. The Conference of the States Parties

Composition. Procedures And Decision-Making

12. The Conference of the States Parties (hereinafter referred to as "the Conference") shall be composed of all States Parties. Each State Party shall have one representative in the Conference, who may be accompanied by alternates and advisers.
13. The initial session of the Conference shall be convened by the Depositary no later than 30 days after the entry into force of this Treaty.
14. The Conference shall meet in regular sessions, which shall be held annually, unless it decides otherwise.
15. A special session of the Conference shall be convened:

(a) When decided by the Conference;
(b) When requested by the Executive Council; or
(c) When requested by any State Party and supported by a majority of the States Parties.

The special session shall be convened no later than 30 days after the decision of the Conference, the request of the Executive Council, or the attainment of the necessary support, unless specified otherwise in the decision or request.
16. The Conference may also be convened in the form of an Amendment Conference, in accordance with Article VII.
17. The Conference may also be convened in the form of a Review Conference, in accordance with Article VIII.
18. Sessions shall take place at the seat of the Organization unless the Conference decides otherwise.
19. The Conference shall adopt its rules of procedure. At the beginning of each session, it shall elect its President and such other officers as may be required. They shall hold office until a new President and other officers are elected at the next session.
20. A majority of the States Parties shall constitute a quorum.
21. Each State Party shall have one vote.
22. The Conference shall take decisions on matters of procedure by a majority of members present and voting. Decisions on matters of substance shall be taken as far as possible by consensus. If consensus is not attainable when an issue comes up for decision, the President of the Conference shall defer any vote for 24 hours and during this period of deferment shall make every effort to facilitate achievement of consensus, and shall report to the Conference before the end of this period. If consensus is not possible at the end of 24 hours, the Conference shall take a decision by a two-thirds majority of members present and voting unless specified otherwise in this Treaty. When the issue arises as to whether the question is one of substance or not, that question shall be treated as a matter of substance unless otherwise decided by the majority required for decisions on matters of substance.
23. When exercising its function under paragraph 26 (k), the Conference shall take a decision to add any State to the list of States contained in Annex 1 to this Treaty in accordance with the procedure for decisions on matters of substance set out in paragraph 22. Notwithstanding paragraph 22, the Conference shall take decisions on any other change to Annex 1 to this Treaty by consensus.

Powers and Functions

24. The Conference shall be the principal organ of the Organization. It shall consider any questions, matters or issues within the scope of this Treaty, including those relating to the powers and functions of the Executive Council and the Technical Secretariat, in accordance with this Treaty. It may make recommendations and take decisions on any questions, matters or issues within the scope of this Treaty raised by a State Party or brought to its attention by the Executive Council.
25. The Conference shall oversee the implementation of, and review compliance with, this Treaty and act in order to promote its object and purpose. It shall also oversee the activities of the Executive Council and the Technical Secretariat and may issue guidelines to either of them for the exercise of their functions.
26. The Conference shall:

(a) Consider and adopt the report of the Organization on the implementation of this Treaty and the annual program and budget of the Organization, submitted by the Executive Council, as well as consider other reports;
(b) Decide on the scale of financial contributions to be paid by States Parties in accordance with paragraph 9;
(c) Elect the members of the Executive Council;
(d) Appoint the Director-General of the Technical Secretariat (hereinafter referred to as "the Director-General");
(e) Consider and approve the rules of procedure of the Executive Council submitted by the latter;
(f) Consider and review scientific and technological developments that could affect the operation of this Treaty. In this context, the Conference may direct the Director-General to establish a Scientific Advisory Board to enable him, in the performance of his functions, to render specialized advice in areas of science and technology relevant to this Treaty to the Conference, the Executive Council or to States Parties. In that case, the Scientific Advisory Board shall be

composed of independent experts serving in their individual capacity and appointed, in accordance with terms of reference adopted by the Conference, on the basis of their expertise and experience in the particular scientific fields relevant to the implementation of this Treaty;

(g) Take the necessary measures to ensure compliance with this Treaty and to redress and remedy any situation that contravenes the provisions of this Treaty, in accordance with Article V;

(h) Consider and approve at its initial session any draft agreements, arrangements, provisions, procedures, operational manuals, guidelines and any other documents developed and recommended by the Preparatory Commission;

(i) Consider and approve agreements or arrangements negotiated by the Technical Secretariat with States Parties, other States and international organizations to be concluded by the Executive Council on behalf of the Organization in accordance with paragraph 38 (h);

(j) Establish such subsidiary organs as it finds necessary for the exercise of its functions in accordance with this Treaty; and

(k) Update Annex 1 to this Treaty, as appropriate, in accordance with paragraph 23.

C. The Executive Council

Composition. Procedures and Decision-Making

27. The Executive Council shall consist of 51 members. Each State Party shall have the right, in accordance with the provisions of this Article, to serve on the Executive Council.

28. Taking into account the need for equitable geographical distribution, the Executive Council shall comprise:

(a) Ten States Parties from Africa;

(b) Seven States Parties from Eastern Europe;

(c) Nine States Parties from Latin America and the Caribbean;

(d) Seven States Parties from the Middle East and South Asia;

(e) Ten States Parties from North America and Western Europe; and

(f) Eight States Parties from South-East Asia, the Pacific and the Far East.

All States in each of the above geographical regions are listed in Annex 1 to this Treaty. Annex 1 to this Treaty shall be updated, as appropriate, by the Conference in accordance with paragraphs 23 and 26 (k). It shall not be subject to amendments or changes under the procedures contained in Article VII.

29. The members of the Executive Council shall be elected by the Conference. In this connection, each geographical region shall designate States Parties from that region for election as members of the Executive Council as follows:

(a) At least one-third of the seats allocated to each geographical region shall be filled, taking into account political and security interests, by States Parties in that region designated on the basis of the nuclear capabilities relevant to the Treaty as determined by international data as well as all or any of the following indicative criteria in the order of priority determined by each region:

(i) Number of monitoring facilities of the International Monitoring System;

(ii) Expertise and experience in monitoring technology; and

(iii) Contribution to the annual budget of the Organization;

(b) One of the seats allocated to each geographical region shall be filled on a rotational basis by the State Party that is first in the English alphabetical order among the States Parties in that region that have not served as members of the Executive Council for the longest period of time since becoming States Parties or since their last term, whichever is shorter. A State Party designated on this basis may decide to forgo its seat. In that case, such a State Party shall submit a letter of renunciation to the Director-General, and the seat shall be filled by the State Party following next-in-order according to this sub-paragraph; and

(c) The remaining seats allocated to each geographical region shall be filled by States Parties designated from among all the States Parties in that region by rotation or elections.

30. Each member of the Executive Council shall have one representative on the Executive Council, who may be accompanied by alternates and advisers.

31. Each member of the Executive Council shall hold office from the end of the session of the Conference at which that member is elected until the end of the second regular annual session of the Conference thereafter, except that for the first election of the Executive Council, 26 members shall be elected to hold office until the end of the third regular annual session of the Conference, due regard being paid to the established numerical proportions as described in paragraph 28.

32. The Executive Council shall elaborate its rules of procedure and submit them to the Conference for approval.

33. The Executive Council shall elect its Chairman from among its members.

34. The Executive Council shall meet for regular sessions. Between regular sessions it shall meet as may be required for the fulfillment of its powers and functions.

35. Each member of the Executive Council shall have one vote.

36. The Executive Council shall take decisions on matters of procedure by a majority of all its members. The Executive Council shall take decisions on matters of substance by a two-thirds majority of all its members unless specified otherwise in this Treaty. When the issue arises as to whether the question is one of substance or not, that question shall be treated as a matter of substance unless otherwise decided by the majority required for decisions on matters of substance.

Powers and Functions

37. The Executive Council shall be the executive organ of the Organization. It shall be responsible to the Conference. It shall carry out the powers and functions entrusted to it in accordance with this Treaty. In so doing, it shall act in conformity with the recommendations, decisions and guidelines of the Conference and ensure their continuous and proper implementation.

38. The Executive Council shall:

(a) Promote effective implementation of, and compliance with, this Treaty;

(b) Supervise the activities of the Technical Secretariat;

(c) Make recommendations as necessary to the Conference for consideration of further proposals for promoting the object and purpose of this Treaty;

(d) Co-operate with the National Authority of each State Party;

(e) Consider and submit to the Conference the draft annual program and budget of the Organization, the draft report of the Organization on the implementation of this Treaty, the report on the performance of its own activities and such other reports as it deems necessary or that the Conference may request;

(f) Make arrangements for the sessions of the Conference, including the preparation of the draft agenda;

(g) Examine proposals for changes, on matters of an administrative or technical nature, to the Protocol or the Annexes thereto, pursuant to Artical VII, and make recommendations to the States Parties regarding their adoption;

(h) Conclude, subject to prior approval of the Conference, agreements or arrangements with States Parties, other States and international organizations on behalf of the Organization and supervise their implementation, with the exception of agreements or arrangements referred to in sub-paragraph (i);

(i) Approve and supervise the operation of agreements or arrangements relating to the implementation of verification activities with States Parties and other States; and

(j) Approve any new operational manuals and any changes to the existing operational manuals that may be proposed by the Technical Secretariat.

39. The Executive Council may request a special session of the Conference.

40. The Executive Council shall:

(a) Facilitate co-operation among State Parties, and between States Parties and the Technical Secretariat, relating to the implementation of this Treaty through information exchanges;

(b) Facilitate consultation and clarification among States Parties in accordance with Article IV; and

(c) Receive, consider and take action on requests for, and reports on, on-site inspections in accordance with Article IV.

41. The Executive Council shall consider any concern raised by a State Party about possible non-compliance with this Treaty and abuse of the rights established by this Treaty. In doing so, the Executive Council shall consult with the States Parties involved and, as appropriate, request a State Party to take measures to redress the situation within a specified time. To the extent that the Executive Council considers further action to be necessary, it shall take, ***inter alia,*** one or more of the following measures:

(a) Notify all States Parties of the issue or matter;

(b) Bring the issue or matter to the attention of the Conference;

(c) Make recommendations to the Conference or take action, as appropriate, regarding measures to redress the situation and to ensure compliance in accordance with Article V.

D. The Technical Secretariat

42. The Technical Secretariat shall assist States Parties in the implementation of this Treaty. The Technical Secretariat shall assist the Conference and the Executive Council in the performance of their functions. The Technical Secretariat shall carry out the verification and other functions entrusted to it by this Treaty, as well as those functions delegated to it by the Conference or the Executive Council in accordance with this Treaty. The Technical Secretariat shall include, as an integral part, the International Data Center.

43. The functions of the Technical Secretariat with regard to verification of compliance with this Treaty shall, in accordance with Article IV and the Protocol, include ***interalia:***

(a) Being responsible for supervising and co-ordinating the operation of the International Monitoring System;

(b) Operating the International Data Center;

(c) Routinely receiving, processing, analyzing and reporting on International Monitoring System data;

(d) Providing technical assistance in, and support for, the installation and operation of monitoring stations;

(e) Assisting the Executive Council in facilitating consultation and clarification among States Parties;

(f) Receiving requests for on-site inspections and processing them, facilitating Executive Council consideration of such requests, carrying out the preparations for, and providing technical support during, the conduct of on-site inspections, and reporting to the Executive Council;

(g) Negotiating agreements or arrangements with States Parties, other States and international organizations and concluding, subject to prior approval by the Executive Council, any such agreements or arrangements relating to verification activities with States Parties or other States; and

(h) Assisting the States Parties through their National Authorities on other issues of verification under this Treaty.

44. The Technical Secretariat shall develop and maintain, subject to approval by the Executive Council, operational manuals to guide the operation of the various components of the verification regime, in accordance with Article IV and the Protocol. These manuals shall not constitute integral parts of this Treaty or the Protocol and may be changed by the Technical Secretariat subject to approval by the Executive Council. The Technical Secretariat shall promptly inform the States Parties of any changes in the operational manuals.

45. The functions of the Technical Secretariat with respect to administrative matters shall include:

(a) Preparing and submitting to the Executive Council the draft program and budget of the Organization;

(b) Preparing and submitting to the Executive Council the draft report of the Organization on the implementation of this Treaty and such other reports as the Conference or the Executive Council may request;

(c) Providing administrative and technical support to the Conference, the Executive Council and other subsidiary organs;

(d) Addressing and receiving communications on behalf of the Organization relating to the implementation of this Treaty; and

(e) Carrying out the administrative responsibilities related to any agreements between the Organization and other international organizations.

46. All requests and notifications by States Parties to the Organization shall be transmitted through their National Authorities to the Director-General. Requests and notifications shall be in one of the official languages of this Treaty. In response the Director-General shall use the language of the transmitted request or notification.

47. With respect to the responsibilities of the Technical Secretariat for preparing and submitting to the Executive Council the draft program and budget of the Organization, the Technical Secretariat shall determine and maintain a clear accounting of all costs for each facility established as part of the International Monitoring System. Similar treatment in the draft program and budget shall be accorded to all other activities of the Organization.

48. The Technical Secretariat shall promptly inform the Executive Council of any problems that have arisen with regard to the discharge of its functions that have come to its notice in the performance of its activities and that it has been unable to resolve through consultations with the State Party concerned.

49. The Technical Secretariat shall comprise a Director-General, who shall be its head and chief administrative officer, and such scientific, technical and other personnel as may be required. The Director-General shall be appointed by the Conference upon the recommendation of the Executive Council for a term of four years, renewable for one further term, but not thereafter. The first Director-General shall be appointed by the Conference at its initial session upon the recommendation of the Preparatory Commission.

50. The Director-General shall be responsible to the Conference and the Executive Council for the appointment of the staff and for the organization and functioning of the Technical Secretariat. The paramount consideration in the employment of the staff and in the determination of the conditions of service shall be the necessity of securing the highest standards of professional expertise, experience, efficiency, competence and integrity. Only citizens of State Parties shall serve as the Director-General, as inspectors or as members of the professional and clerical staff. Due regard shall be paid to the importance of recruiting the staff on as wide a geographical basis as possible. Recruitment shall be guided by the principle that the staff shall be kept to the minimum necessary for the proper discharge of the responsibilities of the Technical Secretariat.

51. The Director-General may, as appropriate, after consultation with the Executive Council, establish temporary working groups of scientific experts to provide recommendations on specific issues.

52. In the performance of their duties, the Director-General, the inspectors, the inspection assistants and the members of the staff shall not seek or receive instructions from any Government or from any other source external to the Organization. They shall refrain from any action that might reflect adversely on their positions as international officers responsible only to the Organization. The Director-General shall assume responsibility for the activities of an inspection team.

53. Each State Party shall respect the exclusively international character of the responsibilities of the Director-General, the inspectors, the inspection assistants and the members of the staff and shall not seek to influence them in the discharge of their responsibilities.

E. Privileges and Immunities

54. The Organization shall enjoy on the territory and in any other place under the jurisdiction or control of a State Party such legal capacity and such privileges and immunities as are necessary for the exercise of its functions.

55. Delegates of States Parties, together with their alternates and advisers, representatives of members elected to the Executive Council, together with their alternates and advisers, the Director-General, the inspectors, the inspection assistants and the members of the staff of the Organization shall enjoy such privileges and immunities as are necessary in the independent exercise of their functions in connection with the Organization.

56. The legal capacity, privileges and immunities referred to in this Article shall be defined in agreements between the Organization and the State Parties as well as in an agreement between the Organization and the State in which the Organization is seated. Such agreements shall be considered and approved in accordance with paragraph 26 (h) and (i).

57. Notwithstanding paragraphs 54 and 55, the privileges and immunities enjoyed by the Director-General, the inspectors, the inspection assistants and the members of the staff of the Technical Secretariat during the conduct of verification activities shall be those set forth in the Protocol.

Article III: National Implementation Measures

1. Each State Party shall, in accordance with its constitutional processes, take any necessary measures to implement its obligations under this Treaty. In particular, it shall take any necessary measures:

(a) To prohibit natural and legal persons anywhere on its territory or in any other place under its jurisdiction as recognized by international law from undertaking any activity prohibited to a State Party under this Treaty;

(b) To prohibit natural and legal persons from undertaking any such activity anywhere under its control; and

(c) To prohibit, in conformity with international law, natural persons possessing its nationality from undertaking any such activity anywhere.

2. Each State Pary shall co-operate with other States Parties and afford the appropriate form of legal assistance to facilitate the implementation of the obligations under paragraph 1.

3. Each State Party shall inform the Organization of the measures taken pursuant to this Article.

4. In order to fulfill its obligations under the Treaty, each State Party shall designate or set up a National Authority and shall so inform the Organization upon entry into force of the Treaty for it. The National Authority shall serve as the national focal point for liaison with the Organization and with other States Parties.

Article IV: Verification

A. General Provisions

1. In order to verify compliance with this Treaty, a verification regime shall be established consisting of the following elements:

(a) An International Monitoring System;

(b) Consultation and clarification;

(c) On-site inspections; and

(d) Confidence-building measures.

At entry into force of this Treaty, the verification regime shall be capable of meeting the verification requirements of this Treaty.

2. Verification activities shall be based on objective information, shall be limited to the subject matter of this Treaty, and shall be carried out on the basis of full respect for the sovereignty of States Parties and in the least intrusive manner possible consistent with the effective and timely accomplishment of their objectives. Each State Party shall refrain from any abuse of the right of verification.

3. Each State Party undertakes in accordance with this Treaty to co-operate, through its National Authority established pursuant to Article III, paragraph 4, with the Organization and with other States Parties to facilitate the verification of compliance with this Treaty by *inter alia:*

(a) Establishing the necessary facilities to participate in these verification measures and establishing the necessary communication;

(b) Providing data obtained from national stations that are part of the International Monitoring System;

(c) Participating, as appropriate, in a consultation and clarification process;

(d) Permitting the conduct of on-site inspections; and

(e) Participating, as appropriate, in confidence-building measures.

4. **All** States Parties, irrespective of their technical and financial capabilities, shall enjoy the equal right of verification and assume the equal obligation to accept verification.

5. For the purposes of this Treaty, no State Party shall be precluded from using information obtained by national technical means of verification in a manner consistent with generally recognized principles of international law, including that of respect for the sovereignty of States.

6. Without prejudice to the right of States Parties to protect sensitive installations, activities or locations not related to this Treaty, States Parties shall not interfere with elements of the verification regime of this Treaty or with national technical means of verification operating in accordance with paragraph 5.

7. Each State Party shall have the right to take measures to protect sensitive installations and to prevent disclosure of confidential information and data not related to this Treaty.

8. Moreover, all necessary measures shall be taken to protect the confidentiality of any information related to civil and military activities and facilities obtained during verification activities.

9. Subject to paragraph 8, information obtained by the Organization through the verification regime established by this Treaty shall be made available to all States Parties in accordance with the relevant provisions of this Treaty and the Protocol.

10. The provisions of this Treaty shall not be interpreted as restricting the international exchange of data for scientific purposes.

11. Each State Party undertakes to co-operate with the Organization and with other States Parties in the improvement of the verification regime, and in the examination of the verification potential of additional monitoring technologies such as electro-magnetic pulse monitoring or satellite monitoring, with a view to developing, when appropriate, specific measures to enhance the efficient and cost-effective verification of this Treaty. Such measures shall, when agreed, be incorporated in existing provisions in this Treaty, the Protocol or as additional sections of the Protocol, in accordance with Article VII, or, if appropriate, be reflected in the operational manuals in accordance with Article II, paragraph 44.

12. The States Parties undertake to promote co-operation among themselves to facilitate and participate in the fullest possible exchange relating to technologies used in the verification of this Treaty in order to enable all States Parties to strengthen their national implementation of verification measures and to benefit from the application of such technologies for peaceful purposes.

13. The provisions of this Treaty shall be implemented in a manner which avoids hampering the economic and technological development of the States Parties for further development of the application of atomic energy for peaceful purposes.

Verification Responsibilities of the Technical Secretariat

14. In discharging its responsibilities in the area of verification specified in this Treaty and the Protocol, in co-operation with the States Parties the Technical Secretariat shall, for the purpose of this Treaty:

(a) Make arrangements to receive and distribute data and reporting products relevant to the verification of this Treaty in accordance with its provisions, and to maintain a global communications infrastructure appropriate to this task;

(b) Routinely through its International Data Center, which shall in principle be the focal point within the Technical Secretariat for data storage and data processing:

(i) Receive and initiate requests for data from the International Monitoring System;

(ii) Receive data, as appropriate, resulting from the process of consultation and clarification, from on-site inspections, and from confidence-building measures; and

(iii) Receive other relevant data from States Parties and international organizations in accordance with this Treaty and the Protocol;

(c) Supervise, co-ordinate and ensure the operation of the International Monitoring System and its component elements, and of the International Data Center, in accordance with the relevant operational manuals;

(d) Routinely process, analyze and report on International Monitoring System data according to agreed procedures so as to permit the effective international verification of this Treaty and to contribute to the early resolution of compliance concerns;

(e) Make available all data, both raw and processed, and any reporting products, to all States Parties, each State Party taking responsibility for the use of International Monitoring

System data in accordance with Article II, paragraph 7, and with paragraphs 8 and 13 of this Article;

(f) Provide to all States Parties equal, open, convenient and timely access to all stored data;

(g) Store all data, both raw and processed, and reporting products;

(h) Co-ordinate and facilitate requests for additional data from the International Monitoring System;

(i) Co-ordinate requests for additional data from one State Party to another State Party;

(j) Provide technical assistance in, and support for, the installation and operation of monitoring facilities and respective communication means, where such assistance and support are required by the State concerned;

(k) Make available to any State Party, on its request, techniques utilized by the Technical Secretariat and its International Data Center in compiling, storing, processing, analyzing and reporting on data from the verification regime; and

(l) Monitor, assess and report on the overall performance of the International Monitoring System and of the International Data Center.

15. The agreed procedures to be used by the Technical Secretariat in discharging the verification responsibilities referred to in paragraph 14 and detailed in the Protocol shall be elaborated in the relevant operational manuals.

B. The International Monitoring System

16. The International Monitoring System shall comprise facilities for seismological monitoring, radionuclide monitoring including certified laboratories, hydroacoustic monitoring, infrasound monitoring, and respective means of communication, and shall be supported by the International Data Center of the Technical Secretariat.

17. The International Monitoring System shall be placed under the authority of the Technical Secretariat. All monitoring facilities of the International Monitoring System shall be owned and operated by the States hosting or otherwise taking responsibility for them in accordance with the Protocol.

18. Each State Party shall have the right to participate in the international exchange of data and to have access to all data made available to the International Data Center. Each State Party shall cooperate with the Interntional Data Center through its National Authority.

Funding the International Monitoring System

19. For facilities incorporated into the International Monitoring System and specified in Tables I-A, 2-A, 3 and 4 of Annex 1 to the Protocol, and for their functioning, to the extent that such facilities are agreed by the relevant State and the Organization to provide data to the International Data Center in accordance with the technical requirements of the Protocol and relevant operational manuals, the Organization, as specified in agreements or arrangements pursuant to Part I, paragraph 4 of the Protocol, shall meet the costs of:

(a) Establishing any new facilities and upgrading existing facilities, unless the State responsible for such facilities meets these cost itself;

(b) Operating and maintaining International Monitoring System facilities, including facility physical security if appropriate, and application of agreed data authentication procedures;

(c) Transmitting International Monitoring System data (raw or processed) to the International Data Center by the most direct and cost-effective means available, including, if necessary, via appropriate communications nodes, from monitoring stations, laboratories, analytical facilities or from national data centers; or such data (including samples where appropriate) to laboratory and analytical facilities from monitoring stations; and

(d) Analyzing samples on behalf of the Organization.

20. For auxiliary network seismic stations specified in Table 1-B of Annex 1 to the Protocol the Organization, as specified in agreements or arrangements pursuant to Part I, paragraph 4 of the Protocol, shall meet the costs only of:

(a) Transmitting data to the International Data Center;

(b) Authenticating data from such stations;

(c) Upgrading stations to the required technical standard, unless the State responsible for such facilities meets these costs itself;

(d) If necessary, establishing new stations for the purposes of this Treaty where no appropriate facilities currently exist, unless the State responsible for such facilities meets these costs itself; and

(e) Any other costs related to the provision of data required by the Organization as specified in the relevant operational manuals.

21. The Organization shall also meet the cost of provision to each State Party of its requested selection from the standard range of International Data Center reporting products and services, as specified in Part I, Section F of the Protocol. The cost of preparation and transmission of any additional data or products shall be met by the requesting State Party.

22. The agreements or, if appropriate, arrangements concluded with States Parties or States hosting or otherwise taking responsibility for facilities of the International Monitoring System shall contain provisions for meeting these costs. Such provisions may include modalities whereby a State Party meets any of the costs referred to in paragraphs 19 (a) and 20 (c) and (d) for facilities which it hosts or for which it is responsible, and is compensated by an appropriate reduction in its assessed financial contribution to the Organization. Such a reduction shall not exceed 50 percent of the annual assessed financial contribution of a State Party, but may be spread over successive years. A State Party may share such a reduction with another State Party by agreement or arrangement between themselves and with the concurrence of the Executive Council. The agreements or arrangements referred to in this paragraph shall be approved in accordance with Article II, paragraphs 26 (h) and 38 (i).

Changes to the International Monitoring System

23. Any measures referred to in paragraph 11 affecting the International Monitoring System by means

of addition or deletion of a monitoring technology shall, when agreed, be incorporated into this Treaty and the Protocol pursuant to Article VII, paragraphs 1 to 6.

24. The following changes to the International Monitoring System, subject to the agreement of those States directly affected, shall be regarded as matters of an administrative or technical nature pursuant to Article VII, paragraphs 7 and 8:

(a) Changes to the number of facilities specified in the Protocol for a given monitoring technology; and

(b) Changes to other details for particular facilities as reflected in the Tables of Annex 1 to the Protocol (including, *inter alia,* State responsible for the facility; location; name of facility; type of facility; and attribution of a facility betwen the primary and auxiliary seismic networks).

If the Executive Council recommends, pursuant to Article VII, paragraph 8 (d) that such changes be adopted, it shall as a rule also recommend pursuant to Article VII, paragraph 8 (g) that such changes enter into force upon notification by the Director-General of their approval.

25. The Director-General, in submitting to the Executive Council and States Parties information and evaluation in accordance with Article VII, paragraph 8 (b), shall include in the case of any proposal made pursuant to paragraph 24:

(a) A technical evaluation of the proposal;

(b) A statement on the administrative and financial impact of the proposal; and

(c) A report on consultations with States directly affected by the proposal, including indication of their agreement.

TemporaryArrangements

26. In cases of significant or irretrievable breakdown of a monitoring facility specified in the Tables of Annex 1 to the Protocol, or in order to cover other temporary reductions of monitoring coverage, the Director-General shall, in consultation and agreement with those States directly affected, and with the approval of the Executive Council, initiate temporary arrangements of no more than one year's duration, renewable if necessary by agreement of the Executive Council and of the States directly affected for another year. Such arrangements shall not cause the number of operational facilities of the International Monitoring System to exceed the number specified for the relevant network; shall meet as far as possible the technical and operational requirements specified in the operational manual for the relevant network; and shall be conducted within the budget of the Organization. The Director-General shall furthermore take steps to rectify the situation and make proposals for its permanent resolution. The Director-General shall notify all States Parties of any decision taken pursuant to this paragraph.

Co-operative National Facilities

27. States Parties may also separately establish co-operative arrangements with the Organization, in order to make available to the International Data Center supplementary data from national monitoring stations that are not formally part of the International Monitoring System.

28. Such co-operative arrangements may be established as follows:

(a) Upon request by a State Party, and at the expense of that State, the Technical Secretariat shall take the steps required to certify that a given monitoring facility meets the technical and operational requirements specified in the relevant operational manuals for an International Monitoring System facility, and make arrangements for the authentication of its data. Subject to the agreement of the Executive Council, the Technical Secretariat shall then formally designate such a facility as a cooperating national facility. The Technical Secretariat shall take the steps required to revalidate its certification as appropriate;

(b) The Technical Secretariat shall maintain a current list of co-operating national facilities and shall distribute it to all States Parties; and

(c) The International Data Center shall call upon data from co-operating national facilities, if so requested by a State Party, for the purposes of facilitating consultation and clarification and the consideration of on-site inspection requests, data transmission costs being borne by that State Party.

The conditions under which supplementary data from such facilities are made available, and under which the International Data Center may request further or expedited reporting, or clarifications, shall be elaborated in the operational manual for the respective monitoring network.

C. Consultation and Clarification

29. Without prejudice to the right of any State Party to request an on-site inspection, States Parties should, whenever possible, first make every effort to clarify and resolve, among themselves or with or through the Organization, any matter which may cause concern about possible non-compliance with the basic obligations of this Treaty.

30. A State Party that receives a request pursuant to paragraph 29 directly from another State Party shall provide the clarification to the requesting State Party as soon as possible, but in any case no later than 48 hours after the request. The requesting and requested States Parties may keep the Executive Council and the Director-General informed of the request and the response.

31. A State Party shall have the right to request the Director-General to assist in clarifying any matter which may cause concern about possible non-compliance with the basic obligations of this Treaty. The Director-General shall provide appropriate information in the possession of the Technical Secretariat relevant to such a concern. The Director-General shall inform the Executive Council of the request and of the information provided in response, if so requested by the requesting State Party.

32. A State Party shall have the right to request the Executive Council to obtain clarification from another State Party on any matter which may cause concern about possible non-compliance with the basic obligations of this Treaty. In such a case, the following shall apply:

(a) The Executive Council shall forward the request for clarification to the requested State Party through the Director-General no later than 24 hours after its receipt;

(b) The requested State Party shall provide the clarification to the Executive Council as soon as possible, but in any case no later than 48 hours after receipt of the request;

(c) The Executive Council shall take note of the clarification and forward it to the requesting State Party no later than 24 hours after its receipt;

(d) If the requesting State Party deems the clarification to be inadequate, it shall have the right to request the Executive Council to obtain further clarification from the requested State Party.

The Executive Council shall inform without delay all other States Parties about any request for clarification pursuant to this paragraph as well as any response provided by the requested State Party.

33. If the requesting State Party considers the clarification obtained under paragraph 32 (d) to be unsatisfactory, it shall have the right to request a meeting of the Executive Council in which States Parties involved that are not members of the Executive Council shall be entitled to take part. At such a meeting, the Executive Council shall consider the matter and may recommend any measure in accordance with Article V.

D. On-Site Inspections

Request for an On-Site Inspection

34. Each State Party has the right to request an on-site inspection in accordance with the provisions of this Article and Part II of the Protocol in the territory or in any other place under the jurisdiction or control of any State Party, or in any area beyond the jurisdiction or control of any State.

35. The sole purpose of an on-site inspection shall be to clarify whether a nuclear weapon test explosion or any other nuclear explosion has been carried out in violation of Article I and, to the extent possible, to gather any facts which might assist in identifying any possible violator.

36. The requesting State Party shall be under the obligation to keep the on-site inspection request within the scope of this Treaty and to provide in the request information in accordance with paragraph 37. The requesting State Party shall refrain from unfounded or abusive inspection requests.

37. The on-site inspection request shall be based on information collected by the International Monitoring System, on any relevant technical information obtained by national technical means of verification in a manner consistent with generally recognized principles of international law, or on a combination thereof. The request shall contain information pursuant to Part II, paragraph 41 of the Protocol.

38. The requesting State Party shall present the on-site inspection request to the Executive Council and at the same time to the Director-General for the latter to begin immediate processing.

Follow-up After Subrnission of an On-Site Inspection Request

39. The Executive Council shall begin its consideration immediately upon receipt of the on-site inspection request.

40. The Director-General, after receiving the on-site inspection request, shall acknowledge receipt of the request to the requesting State Party within two hours and communicate the request to the State Party sought to be inspected within six hours. The Director-General shall ascertain that the request meets the requirements specified in Part II, paragraph 41 of the Protocol, and, if necessary, shall assist the requesting State Party in filing the request accordingly, and shall communicate the request to the Executive Council and to all other States Parties within 24 hours.

41. When the on-site inspection request fulfills the requirements, the Technical Secretariat shall begin preparations for the on-site inspection without delay.

42. The Director-General, upon receipt of an on-site inspection request referring to an inspection area under the jurisdiction or control of a State Party, shall immediately seek clarification from the State Party sought to be inspected in order to clarify and resolve the concern raised in the request.

43. A State Party that receives a request for clarification pursuant to paragraph 42 shall provide the Director-General with explanations and with other relevant information available as soon as possible, but no later than 72 hours after receipt of the request for clarification.

44. The Director-General, before the Executive Council takes a decision on the on-site inspection request, shall transmit immediately to the Executive Council any additional information available from the International Monitoring System or provided by any State Party on the event specified in the request, including any clarification provided pursuant to paragraphs 42 and 43, as well as any other information from within the Technical Secretariat that the Director-General deems relevant or that is requested by the Executive Council.

45. Unless the requesting State Party considers the concern raised in the on-site inspection request to be resolved and withdraws the request, the Executive Council shall take a decision on the request in accordance with paragraph 46.

Executive Council Decisions

46. The Executive Council shall take a decision on the on-site inspection request no later than 96 hours after receipt of the request from the requesting State Party. The decision to approve the on-site inspection shall be made by at least 30 affirmative votes of members of the Executive Council. If the Executive Council does not approve the inspection, preparations shall be stopped and no further action on the request shall be taken.

47. No later than 25 days after the approval of the on-site inspection in accordance with paragraph 46, the inspection team shall transmit to the Executive Council, through the Director-General, a progress inspection report. The continuation of the inspection shall be considered approved unless the Executive Council, no later than 72 hours after receipt of the progress inspection report, decides by a majority of all its members not to continue the inspection. If the Executive Council decides not to continue the inspection, the inspection shall be terminated, and the inspection team shall leave the inspection area and the territory of the inspected State Party as soon as possible in accordance with Part II, paragraphs 109 and 110 of the Protocol.

48. In the course of the on-site inspection, the inspection team may submit to the Executive Council, through the Director-General, a proposal to conduct drilling. The Executive Council shall take a decision on such a proposal no later than 72 hours after receipt of the proposal. The decision to approve drilling shall be made by a majority of all members of the Executive Council.

49. The inspection team may request the Executive Council, through the Director-General, to extend the inspection duration by a maximum of 70 days beyond the 60-day time-frame specified in Part II, paragraph 4 of the Protocol, if the inspection team considers such an extension essential to enable it to fulfill its mandate. The inspection team shall indicate in its request which of the activities and techniques listed in Part II, paragraph 69 of the Protocol it intends to carry out during the extension

period. The Executive Council shall take a decision on the extension request no later than 72 hours after receipt of the request. The decision to approve an extension of the inspection duration shall be made by a majority of all members of the Executive Council.

50. Any time following the approval of the continuation of the on-site inspection in accordance with paragraph 47, the inspection team may submit to the Executive Council, through the Director-General, a recommendation to terminate the inspection. Such a recommendation shall be considered approved unless the Executive Council, no later than 72 hours after receipt of the recommendation, decides by a two-thirds majority of all its members not to approve the termination of the inspection. In case of termination of the inspection, the inspection team shall leave the inspection area and the territory of the inspected State Party as soon as possible in accordance with Part II, paragraphs 109 and 110 of the Protocol.

51. The requesting State Party and the State Party sought to be inspected may participate in the deliberations of the Executive Council on the on-site inspection request without voting. The requesting State Party and the inspected State Party may also participate without voting in any subsequent deliberations of the Executive Council related to the inspection.

52. The Director-General shall notify all States Parties within 24 hours about any decision by and reports, proposals, requests and recommendations to the Executive Council pursuant to paragraphs 46 to 50.

Follow-up after Executive Council Approval of an On-Site Inspection

53. An on-site inspection approved by the Executive Council shall be conducted without delay by an inspection team designated by the Director-General and in accordance with the provisions of this Treaty and the Protocol. The inspection team shall arrive at the point of entry no later than six days following the receipt by the Executive Council of the on-site inspection request from the requesting State Party.

54. The Director-General shall issue an inspection mandate for the conduct of the on-site inspection. The inspection mandate shall contain the information specified in Part II, paragraph 42 of the Protocol.

55. The Director-General shall notify the inspected State Party of the inspection no less than 24 hours before the planned arrival of the inspection team at the point of entry, in accordance with Part II, paragraph 43 of the Protocol.

The Conduct of an On-Site Inspection

56. Each State Party shall permit the Organization to conduct an on-site inspection on its territory or at places under its jurisdiction or control in accordance with the provisions of this Treaty and the Protocol. However, no State Party shall have to accept simultaneous on-site inspections on its territory or at places under its jurisdiction or control.

57. In accordance with the provisions of this Treaty and the Protocol, the inspected State Party shall have:

(a) The right and the obligation to make every reasonable effort to demonstrate its compliance with this Treaty and, to this end, to enable the inspection team to fulfill its mandate;

(b) The right to take measures it deems necessary to protect national security interests and to prevent disclosure of confidential information not related to the purpose of the inspection;

(c) The obligation to provide access within the inspection area for the sole purpose of determining facts relevant to the purpose of the inspection, taking into account sub-paragraph (b) and any constitutional obligations it may have with regard to proprietary rights or searches and seizures;

(d) The obligation not to invoke this paragraph or Part II, paragraph 88 of the Protocol to conceal any violation of its obligations under Article I; and

(e) The obligation not to impede the ability of the inpsection team to move within the inspection area and to carry out inspection activities in accordance with this Treaty and the Protocol.

Access, in the context of an on-site inspection, means both the physical access of the inspection team and the inspection equipment to, and the conduct of inspection activities within, the inspection area.

58. The on-site inspection shall be conducted in the least intrusive manner possible, consistent with the efficient and timely accomplishment of the inspection mandate, and in accordance with the procedures set forth in the Protocol. Wherever possible, the inspection team shall begin with the least intrusive procedures and then proceed to more intrusive procedures only as it deems necessary to collect sufficient information to clarify the concern about possible non-compliance with this Treaty. The inspectors shall seek only the information and data necessary for the purpose of the inspection and shall seek to minimize interference with normal operations of the inspected State Party.

59. The inspected State Party shall assist the inspection team throughout the on-site inspection and facilitate its task.

60. If the inspected State Party, acting in accordance with Part II, paragraphs 86 to 96 of the Protocol, restricts access within the inspection area, it shall make every reasonable effort in consultations with the inspection team to demonstrate through alternative means its compliance with this Treaty.

Observer

61. With regard to an observer, the following shall apply:

(a) The requesting State Party, subject to the agreement of the inspected State Party, may send a representative, who shall be a national either of the requesting State Party or of a third State Party, to observe the conduct of the on-site inspection;

(b) The inspected State Party shall notify its acceptance or non-acceptance of the proposed observer to the Director-General within 12 hours after approval of the on-site inspection by the Executive Council;

(c) In case of acceptance, the inspected State Party shall grant access to the observer in accordance with the Protocol;

(d) The inspected State Party shall, as a rule, accept the proposed observer, but if the inspected State Party exercises a refusal, that fact shall be recorded in the inspection report.

There shall be no more than three observers from an aggregate of requesting States Parties.

Reports of an On-Site Inspection

62. Inspection reports shall contain:

(a) A description of the activities conducted by the inspection team;

(b) The factual findings of the inspection team relevant to the purpose of the inspection;

(c) An account of the co-operation granted during the on-site inspection;

(d) A factual description of the extent of the access granted, including the alternative means provided to the team, during the on-site inspection; and

(e) Any other details relevant to the purpose of the inspection.

Differing observations made by inspectors may be attached to the report.

63. The Director-General shall make draft inspection reports available to the inspected State Party. The inspected State Party shall have the right to provide the Director-General within 48 hours with its comments and explanations, and to identify any information and data which, in its view, are not related to the purpose of the inspection and should not be circulated outside the Technical Secretariat. The Director-General shall consider the proposals for changes to the draft inspection report made by the inspected State Party and shall wherever possible incorporate them. The Director-General shall also annex the comments and explanations provided by the inspected State Party to the inspection report.

64. The Director-General shall promptly transmit the inspection report to the requesting State Party, the inspected State Party, the Executive Council and to all other States Parties. The Director-General shall further transmit promptly to the Executive Council and to all other States Parties any results of sample analysis in designated laboratories in accordance with Part II, paragraph 104 of the Protocol, relevant data from the Internatonal Monitoring System, the assessments of the requesting and inspected States Parties, as well as any other information that the Director-General deems relevant. In the case of the progress inspection report referred to in paragraph 47, the Director-General shall transmit the report to the Executive Council within the time-frame specified in that paragraph.

65. The Executive Council, in accordance with its powers and functions, shall review the inspection report and any material provided pursuant to paragraph 64, and shall address any concerns as to:

(a) Whether any non-compliance with this Treaty has occurred; and

(b) Whether the right to request an on-site inspection has been abused.

66. If the Executive Council reaches the conclusion, in keeping with its powers and functions, that further action may be necessary with regard to paragraph 65, it shall take the appropriate measures in accordance with Article V.

Frivolous or Abusive On-Site Inspection Requests

67. If the Executive Council does not approve the on-site inspection on the basis that the on-site inspection request is frivolous or abusive, or if the inspection is terminated for the same reasons, the Executive Council shall consider and decide on whether to implement appropriate measures to redress the situation, including the following:

(a) Requiring the requesting State Party to pay for the cost of any preparations made by the Technical Secretariat;

(b) Suspending the right of the requesting State Party to request an on-site inspection for a period of time, as determined by the Executive Council; and

(c) Suspending the right of the requesting State Party to serve on the Executive Council for a period of time.

E. Confidence-building Measures

68. In order to:

(a) Contribute to the timely resolution of any compliance concerns arising from possible misinterpretation of verification data relating to chemical explosions; and

(b) Assist in the calibration of the stations that are part of the component networks of the International Monitoring System,

each State Party undertakes to co-operate with the Organization and with other States Parties in implementing relevant measures as set out in Part III of the Protocol.

Article V: Measures to Redress a Situation and to Ensure Compliance, Including Sanctions

1. The Conference, taking into account, ***inter** alia,* the recommendations of the Executive Council, shall take the necessary measures, as set forth in paragraphs 2 and 3, to ensure compliance with this Treaty and to redress and remedy any situation which contravenes the provisions of this Treaty.

2. In cases where a State Party has been requested by the Conference or the Executive Council to redress a situation raising problems with regard to its compliance and fails to fulfill the request within the specified time, the Conference may, ***interalia,*** decide to restrict or suspend the State Party from the exercise of its rights and privileges under this Treaty until the Conference decides otherwise.

3. In cases where damage to the object and purpose of this Treaty may result from non-compliance with the basic obligations of this Treaty, the Conference may recommend to States Parties collective measures which are in conformity with international law.

4. The Conference, or alternatively, if the case is urgent, the Executive Council, may bring the issue, including relevant information and conclusions, to the attention of the United Nations.

Article VI: Settlement of Disputes

1. Disputes that may arise concerning the application or the interpretation of this Treaty shall be settled in accordance with the relevant provisions of this Treaty and in conformity with the provisions of the Charter of the United Nations.

2. When a dispute arises between two or more States Parties, or between one or more States Parties and the Organization, relating to the application or interpretation of this Treaty, the parties concerned shall consult together with a view to the expeditious settlement of the dispute by negotiation or by other peaceful means of the parties' choice, including recourse to appropriate organs of this Treaty and,

by mutual consent, referral to the International Court of Justice in conformity with the Statute of the Court. The parties involved shall keep the Executive Council informed of actions being taken.
3. The Executive Council may contribute to the settlement of a dispute that may arise concerning the application or interpretation of this Treaty by whatever means it deems appropriate, including offering its good offices, calling upon the States Parties to a dispute to seek a settlement through a process of their own choice, bringing the matter to the attention of the Conference and recommending a time-limit for any agreed procedure.
4. The Conference shall consider questions related to disputes raised by States Parties or brought to its attention by the Executive Council. The Conference shall, as it finds necessary, establish or entrust organs with tasks related to the settlement of these disputes in conformity with Article II, paragraph 26 (j).
5. The Conference and the Executive Council are separately empowered, subject to authorization from the General Assembly of the United Nations, to request the International Court of Justice to give an advisory opinion on any legal question arising within the scope of the activities of the Organization. An agreement between the Organization and the United Nations shall be concluded for this purpose in accordance with Article II, paragraph 38 (h).
6. This Article is without prejudice to Articles IV and V.

Article VII: Amendments

1. At any time after the entry into force of this Treaty, any State Party may propose amendments to this Treaty, the Protocol, or the Annexes to the Protocol. Any State Party may also propose changes, in accordance with paragraph 7, to the Protocol or the Annexes thereto. Proposals for amendments shall be subject to the procedures in paragraphs 2 to 6. Proposals for changes, in accordance with paragraph 7, shall be subject to the procedures in paragraph 8.
2. The proposed amendment shall be considered and adopted only by an Amendment Conference.
3. Any proposal for an amendment shall be communicated to the Director-General, who shall circulate it to all States Parties and the Depositary and seek the views of the States Parties on whether an Amendment Conference should be convened to consider the proposal. If a majority of the States Parties notify the Director-General no later than 30 days after its circulation that they support further consideration of the proposal, the Director-General shall convene an Amendment Conference to which all States Parties shall be invited.
4. The Amendment Conference shall be held immediately following a regular session of the Conference unless all States Parties that support the convening of an Amendment Conference request that it be held earlier. In no case shall an Amendment Conference be held less than 60 days after the circulation of the proposed amendment.
5. Amendments shall be adopted by the Amendment Conference by a positive vote of a majority of the States Parties with no State Party casting a negative vote.
6. Amendments shall enter into force for all States Parties 30 days after the deposit of the instruments of ratification or acceptance by all those States Parties casting a positive vote at the Amendment Conference.
7. In order to ensure the viability and effectiveness of this Treaty, Parts I and III of the Protocol and Annexes 1 and 2 to the Protocol shall be subject to changes in accordance with paragraph 8, if the proposed changes are related only to matters of an administrative or technical nature. All other provisions of the Protocol and the Annexes thereto shall not be subject to changes in accordance with paragraph 8.
8. Proposed changes referred to in paragraph 7 shall be made in accordance with the following procedures:

(a) The text of the proposed changes shall be transmitted together with the necessary information to the Director-General. Additional information for the evaluation of the proposal may be provided by any State Party and the Director-General. The Director-General shall promptly communicate any such proposals and information to all States Parties, the Executive Council and the Depositary;

(b) No later than 60 days after its receipt, the Director-General shall evaluate the proposal to determine all its possible consequences for the provisions of this Treaty and its implementation and shall communicate any such information to all States Parties and the Executive Council;

(c) The Executive Council shall examine the proposal in the light of all information available to it, including whether the proposal fulfills the requirements of paragraph 7. No later than 90 days after its receipt, the Executive Council shall notify its recommendation, with appropriate explanations, to all States Parties for consideration. States Parties shall acknowledge receipt within 10 days;

(d) If the Executive Council recommends to all States Parties that the proposal be adopted, it shall be considered approved if no State Party objects to it within 90 days after receipt of the recommendation. If the Executive Council recommends that the proposal be rejected, it shall be considered rejected if no State Party objects to the rejection within 90 days after receipt of the recommendation:

(e) If a recommendation of the Executive Council does not meet with the acceptance required under sub-paragraph (d), a decision on the proposal, including whether it fulfills the requirements of paragraph 7, shall be taken as a matter of substance by the Conference at its next session:

(f) The Director-General shall notify all States Parties and the Depositary of any decision under this paragraph;

(g) Changes approved under this procedure shall enter into force for all States Parties 180 days after the date of notification by the Director-General of their approval unless another time period is recommended by the Executive Council or decided by the Conference.

Article VIII: Review of the Treaty

1. Unless otherwise decided by a majority of the States Parties, ten years after the entry into force of this Treaty a Conference of the States Parties shall be held to review the operation and effectiveness of this Treaty, with a view to assuring itself that the objectives and purposes in the Preamble and the provisions of the Treaty are being realized. Such review shall take into account any new scientific and technological developments relevant to this Treaty. On the basis of a request by any State Party, the Review Conference shall consider the possibility of permitting the conduct of underground nuclear explosions for peaceful purposes. If the Review Conference decides by consensus that such nuclear explosions may be permitted, it shall commence work without delay, with a view to recommending to States Parties an appropriate amendment to this Treaty that shall preclude any military benefits of such nuclear explosions. Any such proposed amendment shall be communicated to the Director-General by any State Party and shall by dealt with in accordance with the provisions of Article VII.
2. At intervals of ten years thereafter, further Review Conferences may be convened with the same objective, if the Conference so decides as a matter of procedure in the preceding year. Such Conferences may be convened after an interval of less than ten years if so decided by the Conference as a matter of substance.
3. Normally, any Review Conference shall be held immediately following the regular annual session of the Conference provided for in Article II.

Article IX: Duration and Withdrawal

1. This Treaty shall be of unlimited duration.
2. Each State Party shall, in exercising its national sovereignty, have the right to withdraw from this Treaty if it decides that extraordinary events related to the subject matter of this Treaty have jeopardized its supreme interests.
3. Withdrawal shall be effected by giving notice six months in advance to all other States Parties, the Executive Council, the Depositary and the United Nations Security Council. Notice of withdrawal shall include a statement of the extraordinary event or events which a State Party regards as jeopardizing its supreme interests.

Article X: Status of the Protocol and the Annexes

The Annexes to this Treaty, the Protocol, and the Annexes to the Protocol form an integral part of the Treaty. Any reference to this Treaty includes the Annexes to this Treaty, the Protocol and the Annexes to the Protocol.

Article XI: Signature

This Treaty shall be open to all States for signature before its entry into force.

Article XII: Ratification

This Treaty shall be subject to ratification by States Signatories according to their respective constitutional processes.

Article XIII: Accession

Any State which does not sign this Treaty before its entry into force may accede to it at any time thereafter.

Article XIV: Entry into Force

1. This Treaty shall enter into force 180 days after the date of deposit of the instruments of ratification by all States listed in Annex 2 to this Treaty, but in no case earlier than two years after its opening for signature.
2. If this Treaty has not entered force three years after the date of the anniversary of its opening for signature, the Depositary shall convene a Conference of the States that have already deposited their instruments of ratification on the request of a majority of those States. That Conference shall examine the extent to which the requirement set out in paragraph 1 has been met and shall consider and decide by consensus what measures consistent with international law may be undertaken to accelerate the ratification process in order to facilitate the early entry into force of this Treaty.
3. Unless otherwise decided by the Conference referred to in paragraph 2 or other such conferences, this process shall be repeated at subsequent anniversaries of the opening for signature of this Treaty, until its entry into force.
4. All States signatories shall be invited to attend the Conference referred to in paragraph 2 and any subsequent conferences as referred to in paragraph 3, as observers.
5. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the 30th day following the date of deposit of their instruments of ratification or accession.

Article XV: Reservations

The Articles of and the Annexes to this Treaty shall not be subject to reservations. The provisions of the Protocol to this Treaty and the Annexes to the Protocol shall not be subject to reservations incompatible with the object and purpose of this Treaty.

Article XVI: Depositary

1. The Secretary-General *of* the United Nations shall be the Depositary of this Treaty and shall receive signatures, instruments of ratification and instruments of accession.
2. The Depositary shall promptly inform all States Signatories and acceding States of the date **of** each signature, the date of deposit of each instrument of ratification or accession, the date **of** the entry into force of this Treaty and *of* any amendments and changes thereto, and the receipt of other notices.
3. The Depositary shall send duly certified copies of this Treaty to the Governments of the States Signatories and acceding States.
4. This Treaty shall be registered by the Depositary pursuant to Article 102 of the Charter of the United Nations.

Article XVII: Authentic Texts

This Treaty, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

Treaty between the United States of America and the Russian Federation on Strategic Offensive Reductions

24 May 2002

Preamble

The United States of America and the Russian Federation, hereinafter referred to as the Parties,

Embarking upon the path of new relations for a new century and committed to the goal of strengthening their relationship through cooperation and friendship,

Believing that new global challenges and threats require the building of a qualitatively new foundation for strategic relations between the Parties,

Desiring to establish a genuine partnership based on the principles of mutual security, cooperation, trust, openness, and predictability,

Committed to implementing significant reductions in strategic offensive arms,

Proceeding from the Joint Statements by the President of the United States of America and the President of the Russian Federation on Strategic Issues of July 22, 2001 in Genoa and on a New Relationship between the United States and Russia of November 13, 2001 in Washington,

Mindful of their obligations under the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms of July 31, 1991, hereinafter referred to as the START Treaty,

Mindful of their obligations under Article VI of the Treaty on the Non-Proliferation of Nuclear Weapons of July 1, 1968, and,

Convinced that this Treaty will help to establish more favourable conditions for actively promoting security and cooperation, and enhancing international stability,

Have agreed as follows;

Article I

1. Each Party shall reduce and limit strategic nuclear warheads, as stated by the President of the United States of America on November 13,2001 and as stated by the President of the Russian Federation on November 13, 2001 and December 13, 2001 respectively, so that by December 31, 2012 the aggregate number of such warheads does not exceed 1700-2200 for each Party. Each Party shall determine for itself the composition and structure of its strategic offensive arms, based on the established aggregate limit for the number of such warheads.

Article II

The Parties agree that the STARTTreaty remains in force in accordance with its terms

Article III

For purposes of implementing this Treaty, the Parties shall hold meetings at least twice a year of a Bilateral Implementation Commission.

Article IV

1. This Treaty shall be subject to ratification in accordance with the constitutional procedures of each Party. This Treaty shall enter into force on the date of the exchange of instruments of ratification.
2. This Treaty shall remain in force until December 31, 2012 and may be extended by agreement of the Parties or superseded earlier by a subsequent agreement.
3. Each Party, in exercising its national sovereignty, may withdraw from this Treaty upon three months written notice to the other Party.

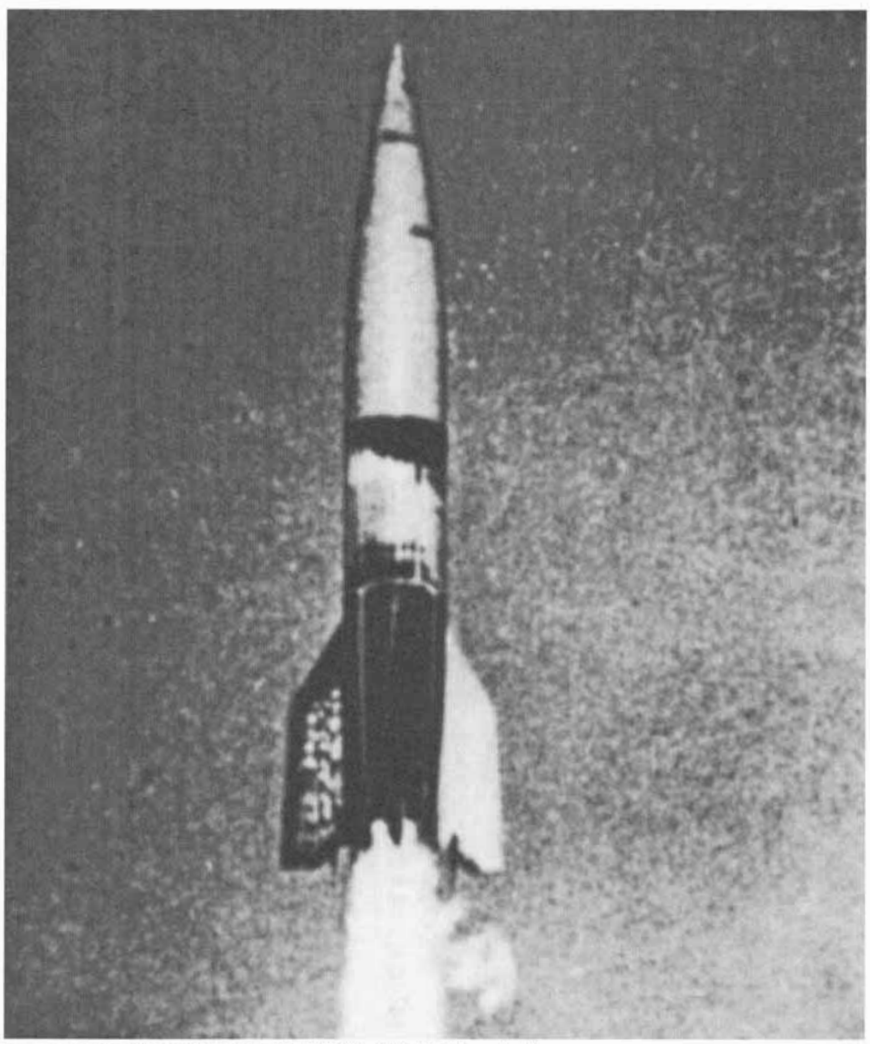
Article V

This Treaty shall be registered pursuant to Article 102 of the Charter of the United Nations

Done at Moscow on May 24, 2002, in two copies, each in the English and Russian languages, both texts being equally authentic.

For the United States Of America
For the Russian Federation

WEAPON INVENTORIES



The successful test launch of a V-2 (A-4) ballistic missile

OFFENSIVE WEAPONS TABLES

LAND-BASED BALLISTIC MISSILES

Missile name and designation	Length	Diameter	Launch weight	Payload	Propulsion	Range	Status	In-service
Argentina								
Alacran	6.2 m	0.56 m	1,620 kg	single HE	solid	150 km	operational	1990
People's Republic of China								
CSS-2 (DF-3)	21.2 m	2.25 m	64,000 kg	single HE/1-3 MT	liquid	2,650 km	operational	1970
CSS-2 (DF-3A)	21.2 m	2.25 m	64,000 kg	single HE/1-3 MT	liquid	2,400/ 2,800 km	operational	1988
CSS-3 (DF-4)	28.0 m	2.25 m	82,000 kg	single 2 MT	liquid	4,750 km	operational	1978
CSS-4 (DF-5)	32.6 m	3.35 m	183,000 kg	single 1-3 MT	liquid	12,0001 13,000 km	operational	1980
CSS-4 (DF-5A)	32.6 m	3.35 m	183,000 kg	single 1-3 MT or 4-6 MIRV 150-350 kT	liquid	12,000 km	operational	1995
CSS-5 (DF-21)	10.07 m	1.4 m	14,700 kg	single nuclear 250 kT/ HE/chemical	solid	2,150 km	operational	1987
CSS-5 Mod 2 (DF-21A)	12.3 m	1.4 m	15,200 kg	single nuclear 90 kT or selectable 20150 kT/HE/ chemical	solid	2,500 km	operational	1996
CSS-6 (DF-15/M9)	9.1 m	1.0 m	6,200 kg	single HE/nuclear 90 kT/ chemical/EMP	solid	600 km	operational	1990 (DF-15), 1996 (DF-15A)
CSS-7 (DF-11/M-11)	7.5 m	0.8 m	3,800 kg	single HE/nuclear selectable 2-20 kT/ chemical	solid	280 km	operational	1992
CSS-7 Mod 2 (DF-11A)	8.5 m	0.8 m	4,200 kg	single HE/nuclear selectable 2-20 kT/ chemical	solid	300 km	operational	1998
CSS-8 (M-7/8610)	10.8 m	0.65 m	2,650 kg	single HE/chemical	solid	150 km	operational	1992
M-18	n/k	n/k	n/k	single HE	solid	1,000 km	unknown	–
CSS-9 (DF-31)	16.0 m	2.0 m	42,000 kg	single 1MT or 3 MIRV selectable 20-150 kT	solid	8,000 km (DF-31). 10,000 km (DF-31A)	operational	1999 (DF-31), 2002 (DF-31A)
DF-25	n/k	n/k	n/k	single HE	solid	2,500 km	development	2005
CSS-X-10 (DF-41)	18.5 m	2.0 m	53,000 kg	single 1MT or 3 MIRV selectable 20-150 kT	solid	12,000 km	development	2004
Guided WM-80	4.58 m	0.27 m	505 kg	single HE	solid	120 km	operational	2001
Egypt								
Project T	11.16 m	0.88 m	6,370 kg	single HE	liquid	450 km	operational	1993
India								
Prithvi SS-150	8.53 m	0.9 m	4,400 kg	single HE	liquid	150 km	operational	1994
Prithvi SS-250	8.53 m	0.9 m	4,400 kg	single HE	liquid	250 km	operational	1996
Prithvi SS-350	n/k	1.1 m	n/k	single HE	liquid	350 km	development	2004
Agni 1	21.0 m	1.3/0.9 m	19,000 kg	single HE/chemical/ 45 or 200 kT	solid and liquid	2.500 km	operational	1998
Agni 2	20.0 m	1.0/0.8 m	16,000 kg	single HE/chemical/ 200 kT	solid	3,000 km	operational	2000
Agni 2 upgrade	20.0 m	1.0/0.8 m	16,000 kg	single HE/chemical/ 200 kT	solid	3,500 km	development	2002
Agni 3	n/k	n/k	n/k	single HE/chemical/ 200 kT	solid	5,000km	development	2005
International								
Condor 2	10.5 m	0.8 m	5,200 kg	single HE/chemical	solid	900 km	cancelled	–
Iran								
M-11 variant	7.5 m	0.88 m	5,000 kg	single HE	solid	300 km	development	2003
'Scud B' variant	11.16 m	0.88 m	6,370 kg	single HE/chemical	liquid	300 km	operational	1987
'Scud C' variant	12.0 m	0.88 m	7,000 kg	single HE	liquid	550 km	operational	1993
M-9 variant	9.1 m	1.0 m	6,200 kg	single HE	solid	700 km	development	2004
Shahab 3	16.0 m	1.32 m	16,250 kg	single HE/chemical	liquid	1,300 km	operational	1999
Shahab 4	n/k	n/k	n/k	single HE/chemical	liquid	2,000 km	development	2003
Iraq								
Al Hussein	12.46 m	0.88 m	6,400 kg	single HE/chemical/ biological	liquid	630 km	operational	1988
SRBM	n/k	n/k	n/k	single HE	solid	150 km	development	2004
Israel								
Jericho 1 (YA.I)	10.0 m	1.0 m	6,700 kg	single HE/chemical/ nuclear	solid	500 km	operational	1973
Jericho 2 (YA-3)	14.0 m	1.56 m	26,000 kg	single HE/nuclear	solid	1,500-3,500 km	operational	1990
Jericho 3 (YA-4)	n/k	n/k	n/k	n/k	solid	4,800 km	development	2004
North Korea								
'Scud B variant (Hwasong *5)*	10.9 m	0.88 m	5,840 kg	single HE/chemical	liquid	300 km	operational	1986
'Scud C' variant (Hwasong 6)	10.9 m	0.88 m	6,200 kg	single HE	liquid	500 km	operational	1992
'Scud D' variant (Hwasong 7)	13.5 m	0.88 m	6,400 kg	single HE	liquid	650 km	operational	1994
No-dong-1	16.0 m	1.32 m	16,250 kg	single HE/chemical/ nuclear	liquid	1,300 km	operational	1993
No-dong-2	16.0 m	1.32 m	16,250 kg	single HE/chemical/ nuclear	liquid	1,500 km	operational	1998
Taep'c-dong 1	27.0 m	1.32/0.88 m	21,700 kg	single HE/nuclear	liquid	2,000 km	operational	1998
Taep'c-dong 1 (SLV)	32.0 m	1.32/0.88/ 0.88 m	25,700 kg	single HE/nuclear	liquid/solid	5,000 km	development	2002
Taep'c-dong 2	35.0 m	2.4/1.33 m	64,000 kg	single HE/nuclear	liquid	6,000 km	development	2004

Missile name and designation	Length	Diameter	Launch weight	Payload	Propulsion	Range	Status	In-service
South Korea								
NHK-1	12.2 m	0.54 m	4,900 kg	single HE	solid	250 km	operational	1980
Pakistan								
Hatf 1/1A/1B	6.0 m	0.56 m	1,500 kg	single HE/chemical	solid	80-100 km	operational	1992
Hatf 2	9.75 m	0.56 m	3,000 kg	single HE/chemical	solid	300 km	development	2004
Hatf 2A	8.5 m	0.8 m	5,300 kg	single HE/chemical/ nuclear	solid	300 km	operational	1997
Hatf 3	10.0 m	1.0 m	6,500 kg	single HE/chemical/ nuclear	solid	550 km	development	2004
Hatf 4 (Shaheen 1)	12.0 m	1.0 m	9,500 kg	single HE/chemical/ nuclear	solid	600 km	operational	1999
Hatf 5 (Ghauri 1)	15.9 m	1.35 m	15,850 kg	single HE/chemical/ nuclear	liquid	1,500 km	operational	1998
Hatf 5A (Ghauri 2)	18.0 m	1.35 m	17,800 kg	single HE/chemical/ nuclear	liquid	1,800–2,300 km	operational	2001
Hatf 6 (Shaheen 2)	17.0 m	1.4 m	25,000 kg	single HE/chemical/ nuclear	solid	2,500 km	operational	2002
Russian Federation								
FROG-76	9.4 m	0.54 m	2,450-2,485 kg	single HE/chemical/ nuclear 3-200 kT	solid	68 km	operational	1965
SS-1B 'Scud A	10.7 m	0.88 m	5,500 kg	single 50 kT	liquid	190 km	operational	1958
SS-1C 'Scud B'	11.25 m	0.88 m	5,900 kg	single HE/chemical/ nuclear 5-70 kT	liquid	300 km	operational	1965
SS-1D 'Scud C'	11.25 m	0.88 m	6,400 kg	single HE	liquid	550 km	n/k	–
SS-1E 'Scud D	12.29 m	0.88 m	6,500 kg	single HE/chemical/ nuclear	liquid	300 km	n/k	–
SS-18 'Satan' Mod 1	33.6 m	3.0 m	210,000 kg	8 MIRV 1.3MT	liquid	10,200 km	superseded	1975
SS-18 'Satan' Mod 2	33.6 m	3.0 m	210,000 kg	single 24 MT	liquid	11,000 km	superseded	1978
SS-18 'Satan' Mod 3	34.3 m	3.0 m	217,000 kg	10MIRV 500 to 550 kT	liquid	15,000 km	operational	1980
SS-18 'Satan' Mod 4	34.3 m	3.0 m	217,000 kg	10 MIRV 500-750 kT	liquid	15,000 km	operational	1988
SS-19 'Stiletto' Mod 1	24.0 m	2.5 m	92,700 kg	6 MIRV 500 kT	liquid	9,000 km	operational	1975
SS-19 'Stiletto' Mod 2	24.3 m	2.5 m	105,600 kg	6 MIRV 500-750kT	liquid	10,000 km	operational	1980
55-21 'Scarab A'	6.4 m	0.65 m	2,000 kg	single HE/chemical/ nuclear	solid	70 km	operational	1976
58-21 'Scarab B'	6.4 m	0.65 m	2,010 kg	single HE/chemical/ nuclear	solid	120 km	operational	1986
SS-23 'Spider'	7.32 m	0.97 m	4,630 kg	single HE/nuclear/ chemical	solid	500 km	operational	1980
58-24 'Scalpel'	22.4 m (1), 22.3 m (2)	2.4 m	104,500 kg	10 MIRV550 kT	solid	10,000 km	operational	1987 (rail), 1989 (silo)
SS-25 'Sickle'	20.5 m	1.8/1.55/1.34 m	45,100 kg	single 550 kT	solid	10,500 km	operational	1988
SS-X-26	7.3 m	0.92 m	3,800–4,020 kg	single HE	solid	280 or 400 km	development	2002
SS-27 (Topol-M)	21.9 m	1.9/1.61/1.58 m	47,200 kg	single 550 kT	solid	10,500 km	operational	1997
Taiwan								
Green Bee (Ching Feng)	6.4 m	0.6 m	1,500 kg	single HE	liquid	130 km	operational	1982
Tien Ma 1 (Sky Horse)	n/k	n/k	n/k	single HE	solid	950 km	development	2003
USA								
MGM-140 ATACMS Block 1	3.98 m	0.61 m	1,673 kg	single, submunitions	solid	165 km	operational	1991
MGM-140 ATACMS Block 1A	3.98 m	0.61 m	1,321 kg	submunitions or single	solid	270 or 300 km	operational	1998
MGM-140 ATACMS Block 2	3.98 m	0.61 m	1,483 kg	HE submunitions	solid	140 km	development	2002
MGM-52 Lance	6.41 m	0.58 m	1,527 kg	single HE/100 kT/ submunitions	liquid	130 km	operational	1972
LGM-30G Minuteman III	18.2 m	1.85 m	34,467 kg	3 MIRV 335 kT	solid	13,000 km	operational	1974
LGM-I18 Peacekeeper	21.6 m	2.34 m	88,450 kg	10 MIRV 500 kT	solid	9,600 km	operational	1986
Guided MLRS	3.94 m	0.23 m	296 kg	submunitions	solid	60 km	development	2003

LAND-BASED SSM AND CRUISE MISSILES

Missile name and designation	Length	Diameter	Launch weight	Payload	Propulsion	Range	Status	In-service
People's Republic of China								
CSSC-2 (HY-1)	5.8 m	0.78 m	2,300 kg	single HE	liquid	85 km	operational	1974
CSSC-3 (HY-2/C-201)	7.36 m	0.76 m	3,000 kg	single HE	liquid	95 km	operational	1978
CSSC-5 (YJ-16/C-101)	6.5 m	0.54 m	1,850 kg	single HE	ramjet	45 km	operational	1995
CSSC-6 (HY-3)	9.85 m	0.76 m	4,900 kg (3), 4,600 kg (3A)	single HE	ramjet	140 km (3), 180 km (3A)	operational	1995(3), 2001 (3A)
CSSC-7 (HY-4)	7.36 m	0.76 m	1,950 kg	single HE	turbojet	135/200 km	operational	1985
CSSN-4 (YJ-1/C-801)	5.81 m	0.36 m	815 kg	single HE	solid	40 /70 km	operational	1984
CSSC-8 (YJ-2/C-802)	6.39 m	0.36 m	715 kg	single HE	turbojet	120 /180 km	operational	1995
HN-1	6.4 m	0.5 m	1,200 kg	single HE or 20-90 kT	turbojet	650 km	operational	1996
HN-2	6.4 m	0.7 m	1,400 kg	single HE or 20-90 kT	turbofan	1,800 km	operational	2001
HN-3	6.4 m	0.75 m	1,800 kg	single HE or 20-90 kT	turbofan	3,000 km	development	2005
CF-2000	6.8 m	0.47 m	1,600 kg	single HE	solid	150 km	development	2002
France								
MM 38	5.21 m	0.35 m	735 kg	single HE	solid	40 km	operational	1975
MM 40	5.8 m	0.35 m	870 kg	single HE	solid	70 km	operational	1981

Missile name and designation	Length	Diameter	Launch weight	Payload	Propulsion	Range	Status	In-sewice
International								
Otomat Mk 1	4.46 m	0.46 m	770 kg	single HE	turbojet	60 km	operational	1976
Otomat Mk 2/3	4.46 m	0.46 m	770 kg	single HE	turbojet	180 km	operational	1984/2001
Polyphem	2.7 m	0.22 m	140 kg	single HE	turbojet	60 km	development	2007
PJ-10 Brahmos	8.1 m	0.67 m	3,000 kg	single HE	ramjet	300 km	development	2002
Iraq								
FAW 70	6.55 m	0.78 m	2,500 kg	single HE/ chemical	liquid	80 km	operational	1989
FAW 150	8.1 m	0.78 m	2,650 kg	single HE/ chemical	liquid	150 km	operational	1989
FAW 200	8.9 m	0.78 m	2,740 kg	single HE/ chemical	liquid	200 km	operational	1989
Israel								
Gabriel Mk 2	3.42 m	0.34 m	522 kg	single HE	solid	35 km	operational	1976
Gabriel Mk 3	3.85 m	0.34 m	560 kg	single HE	solid	35 km	operational	1980
Gabriel Mk 4 LR	4.7 m	0.44 m	960 kg	single HE	turbojet	200 km	operational	1992
Japan								
SSM-1A/1B (type 88/90)	5.08 m	0.34 m	660 kg	single HE	turbojet	150 km	operational	1988/1990
North Korea								
HY-2 variant	7.36 m	0.76 m	3,000 kg	single HE	liquid	95 km	operational	1983
HY-2 improvement	8.0 m	0.76 m	3,250 kg	single HE	liquid	160 km	development	2002
Norway								
Penguin Mk 2	3.0 m	0.28 m	385 kg	single HE	solid	30 km	operational	1979
Russian Federation								
ssc-3 'Styx'	6.5 m	0.78 m	2,500 kg	single HE	liquid	80 km	Operational	1975
SS-N-3B/C 'Shaddock/Sepal'	10.2 m	0.98 m	5,300 kg	single HE/nuclear	turbojet	450 km	operational	1963
SSN-22 'Sunburn'	9.4 m	0.76 m	3,950 kg	single HE	ramjet	90/120 km	operational	1994
SSGX-5 (SS-NX-26)	8.9m	0.67 m	3,000 kg	single HE	ramjet	300 km	development	2002
SSC-6 (SS-N-25)	4.2 m	0.42 m	630 or 700 kg	single HE	turbofan	130/250 km	operational	1994
P-270 Moskit (Kh-41)	9.74 m	0.76 m	4,500 kg	single HE/nuclear	ramjet	250 km	development	2002
Sweden								
RBS-15K	4.35 m	0.5 m	790 kg	single HE	turbojet	100 km	operational	1985
Taiwan								
Hsiung Feng 1	3.42 m	0.34 m	522 kg	single HE	solid	35 km	operational	1980
Hsiung Feng 2	4.6 m	0.34 m	685 kg	single HE	turbojet	80 km	operational	1993
Hsiung Feng 3	6.25 m	0.42 m	1,500 kg	single HE	ramjet	300 to 600 km	development	2005
USA								
RGM-84 Harpoon	4.64 m	0.34 m	682 kg	single HE	turbofan	130 km	operational	1977

SEA-BASED BALLISTIC MISSILES

Missile name and designation	Length	Diameter	Launch weight	Payload	Propulsion	Range	Status	In-service
People's Republic of China								
CSS-N-3 (JL-1)	10.7 m	1.4 m	14,700 kg	single 250 kT	solid	2,150 km	operational	1983
CSS-N-3 Mod 1 (JL-1A)	12.3 m	1.4 m	15,200 kg	single 90 kT or selectable 20-150 kT	solid	2,500 km	operational	2001
CSSNX-5 (JL-2)	16.0 m	2.0 m	42,000 kg	single 1 MT or 3 MIRV selectable 20-150 kT	solid	8,000 km	development	2005
France								
M-4	11.05 m	1.93 m	35,000 kg	6 MRV 100 kT	solid	4,000 km	operational	1985
M-45	11.05 m	1.93 m	35,000 kg	6 MIRV 100 kT	solid	6,000 km	operational	1996
M-51	13.0 m	2.35 m	50,000 kg	6 MRV 100 kT	solid	10,000 km	development	2008
India								
Dhanush	8.53 m	0.9 m	4,400 kg	single HE	liquid	250 km	development	2002
Russian Federation								
SSN-8 'Sawfly' Mod 1	13.9 m	1.8 m	33,300 kg	single 1 MT	liquid	7,800 km	operational	1973
SS-N-8 'Sawfly' Mod 2	13.9 m	1.8 m	33,300 kg	single 800 kT	liquid	9,100 km	operational	1974
SSN-18 'Stingray' Mod 1	14.6 m	1.8 m	35,300 kg	3 MIRV 500 kT	liquid	6,500 km	operational	1977
SS-N-20 'Sturgeon'	16.1 m	2.4 m	87,600 kg	10 MIRV 200 kT	solid	8,300 km	operational	1983
SS-N-23 'Skiff	14.8 m	1.9 m	40,300 kg	4 MIRV 100 kT	liquid	8,300 km	operational	1985
USA								
UGM-96 C-4 Trident	10.39 m	1.88 m	32,850 kg	8 MIRV 100 kT	solid	7,400 km	operational	1984
UGM-133 D-5 Trident	13.42 m	2.11 m	59,090 kg	8 MIRV 100 kT or 475 kT	solid	12,000 km	operational	1990

SEA-BASED SSM AND CRUISE MISSILES

Missile name and designation	Length	Diameter	Launch weight	Payload	Propulsion	Range	Status	In-service
People's Republic of China								
CSS-N-2 (HY-1)	5.8 m	0.76 m	2,300 kg	single HE	liquid	85 km	operational	1974
CSSC-3 (HY-2/C-201)	7.36 m	0.76 m	3,000 kg	single HE	liquid	95 km	operational	1978
CSSC-7 (HY-4)	7.36 m	0.76 m	2,000 kg	single HE	turbojet	150 km	operational	1985
CSS-N-1 (FL-1)	6.42 m	0.76 m	2,000 kg	single HE	liquid	45 km	operational	1980
CSS-Nd (FL-2)	6.0 m	0.54 m	1,550 kg	single HE	solid	50 km	operational	1983
FL-7	6.6 m	0.54 m	1,800 kg	single HE	liquid	30 km	operational	1996
CSSN-4 (YJ-1/C-801)	5.81 m	0.38 m	815 kg	single HE	solid	40/70 km	operational	1984
CSSC-8 (YJ-2/C-802)	6.39 m	0.36 m	715 kg	single HE	turbojet	120/180 km	operational	1995
CSSC-5 (YJ-16/C-101)	6.5 m	0.54 m	1,850 kg	single HE	ramjet	45 km	operational	1995
CY-1	5.5 m	n/k	700 kg	single torpedo HE	solid	18 km	operational	1986
France								
MM 38 Exocet	5.21 m	0.35 m	735 kg	single HE	solid	40 km	operational	1975
MM 40 Exocet	5.8 m	0.35 m	870 kg	single HE	solid	70 km	operational	1981
SM 39 Exocet	4.69 m	0.35 m	655 kg	single HE	solid	50 km	ooerational	1985
Germany								
KEPD 150-SLM	5.6 m	0.63/0.32 m	1,160 kg	single HE	turbojet	270 km	development	2005
India								
Koral	9.15 m	0.55 m	2,200 kg	single HE	solid	110 km	development	2003
Sagrika	n/k	n/k	n/k	single HE	turbojet	300 km	development	2004
International								
Otomat Mk 1	4.46 m	0.46 m	770 kg	single HE	turbojet	60 km	operational	1976
Otomat Mk 2	4.46 m	0.46 m	770 kg	single HE	turbojet	180 km	operational	1984
Otomat Mk 3	4.46 m	0.46 m	770 kg	single HE	turbojet	180 km	operational	1997
Teseo Mk 3	5.6 m	0.46 m	800 kg	single HE	turbojet	250 km	development	2003
Milas	6.0 m	0.46 m	800 kg	single torpedo	turbojet	55 km	development	2002
Triton	2.0 m	0.22 m	120 kg	single HE	solid	15 km	development	2008
PJ-10 Brahmos	8.1 m	0.67 m	3,000 kg	single HE	ramjet	300 km	development	2003
Israel								
Gabriel Mk 2	3.42 m	0.34 m	522 kg	single HE	solid	35 km	operational	1976
Gabriel Mk 3	3.85 m	0.34 m	560 kg	single HE	solid	35 km	operational	1980
Gabriel Mk 4 LR	4.7 m	0.44 m	960 kg	single HE	turbojet	200 km	operational	1992
Italy								
Sea Killer Mk2	4.7 m	0.21 m	300 kg	single HE	solid	25 km	operational	1971
Marte 2N	5.0 m	0.32 m	324 kg	single HE	solid	25 km	development	2002
Japan								
SSM-1A/1B	5.08 m	0.34 m	660 kg	single HE	turbojet	150 km	operational	1988/1990
Norway								
Penguin Mk 2	2.96 m	0.28 m	340 kg	single HE	solid	27 km	operational	1979
Russian Federation								
SS-N-2A/B 'Styx'	5.2 m	0.76 m	2,100 kg	single HE	liquid	35/40 km	operational	1959/1961
SS-N-2C/D/E 'Styx'	6.5 m	0.78 m	2,500 kg	single HE	liquid	80 km	operational	1962
SS-N-3B/C 'Shaddock/Sepal'	10.2 m	0.98 m	5,300 kg	single HE/nuclear	turbojet	300 or 450 km	operational	1963
SS-N-9 'Siren'	8.84 m	0.8 m	3,300 kg	single HE/nuclear	solid	110 km	operational	1969
SS-N-12 'Sandbox'	11.7 m	0.88 m	4,800 to 5,000 kg	single HE/nuclear 350 kT	turbojet	550 km	operational	1975
SS-N-14 'Silex' (83R/84R)	7.2 m	1.35/0.55 m	3,700 kg	single HE/nuclear	solid	55 km	operational	1968
SSN-14 'Silex' (85-RU)	7.2 m	1.35/0.57 m	3,930 kg	single HE	solid	50 km	operational	1969/1973
SS-N-15 'Starfish' (81R)	6.9 m	0.35 m	1,800 kg	single HE/nuclear	solid	35 km	Operational	1969
SS-N-16A 'Stallion' (86R)	8.17 m	0.53 m	2,445 kg	single HE/nuclear	solid	50 km	operational	1981
SS-N-16B 'Stallion' (88R)	8.17 m	0.65 m	2,850 kg	single HE/nuclear	solid	120 km	operational	1984
SS-N-16C (100RU)	8.17 m	0.65 m	2,850kg	single HE/nuclear	solid	200 km	operational	1989
SS-N-19 'Shipwreck'	10.0 m	0.85 m	6,980 kg	single HE/nuclear 500 kT	turbojet	550 km	operational	1980
SS-N-21 'Sampson'	8.09 m	0.51 m	1,700 kg	single nuclear 200 kT/HE	turbofan	3000 km	operational	1987
SS-N-22 'Sunburn'	9.39 m	0.76 m	3,950 kg	single HE/nuclear 200 kT	ramjet	90 km	operational	1980
3M 80E	9.39 m	0.76 m	4,150 kg	single HE/nuclear 200 kT	ramjet	120 km	operational	1990
SS-N-25 (Kh-35)	4.2 m	0.42 m	603 kg	single HE	turbofan	130 km	operational	1993
SS-N-25 (Kh-35 mod 1)	4.2 m	0.42 m	700 kg	single HE	turbofan	250 km	operational	1998
SS-NX-26	8.9 m	0.67 m	3,000 kg	single HE	ramjet	300 km	development	2002
SSNX-27 Club (3M54)	8.22 m	0.53 m	2,300 kg	single HE	turbojet	220 km	development	2002
SS-NX-27 Club (3M54M1)	6.2 m	0.53 m	1,780 kg	single HE	turbojet	300 km	development	2002
SS-NX-27 Club (3M14)	6.2 m	0.53 m	1,780 kg	single HE	turbojet	300 km	development	2002
91R1	8.0 m	0.51 m	2,050 kg	torpedo	solid	50 km	development	2002
91R2	6.2 m	0.51 m	1,200 kg	torpedo	solid	40 km	development	2002
SS-N-29 Medvedka	5.35 m	0.4 m	750 kg	single torpedo	solid	25 km	operational	1997
P-270 Moskit (Kh-41)	9.74 m	0.76 m	4,500 kg	single HE/nuclear	ramjet	250 km	development	2003
Sweden								
RBS-15M Mk 1	4.35 m	0.5 m	790 kg	single HE	turbojet	100 km	operational	1985
RBS-15M Mk 2	4.35 m	0.5 m	800 kg	single HE	turbojet	150 km	operational	1998
Taiwan								
Hsiung Feng 1	3.42 m	0.34 m	522 kg	single HE	solid	35 km	operational	1980
Hsiung Feng 2	4.6 m	0.34 m	685 kg	single HE	turbojet	80 km	operational	1990
UK								
Sea Skua SL	2.5 m	0.25 m	147 kg	single HE	solid	15 km	operational	2000

Missile name and designation	Length	Diameter	Launch weight	Payload	Propulsion	Range	Status	In-service
USA								
RGM/UGM-109A Tomahawk (TLAM-N)	6.25 m	0.52 m	1,452 kg	single nuclear 200 kT	turbofan	2,500 km	operational	1983
RGM/UGM-109B Tomahawk (TASM)	6.25 m	0.52 m	1,452 kg	single HE	turbofan	450 km	operational	1983
RGM/UGM-109C Tomahawk (TLAM-C)	6.25 m	0.52 m	1,452 kg	single HE	turbofan	900-1,700 km	operational	1983
RGM/UGM-109D Tomahawk (TLAM-D)	6.25 m	0.52 m	1,452 kg	single submunitions	turbofan	900-7,300 km	operational	1989
RUR-5 ASROC	4.57 m	0.33 m	435 kg	single torpedo/ nuclear	solid	10 km	operational	1961
RGM/UGM-84 Harpoon	4.64 m	0.34 m	682 kg	single HE	turbofan	130 km	operational	1977
RGM-84E Sea SLAM	5.25 m	0.34 m	780 kg	single HE	turbofan	85 km	development	2002
RUM-139 VL-ASROC	5.08 m	0.35 m	635 kg	single torpedo	solid	45 km	operational	1995

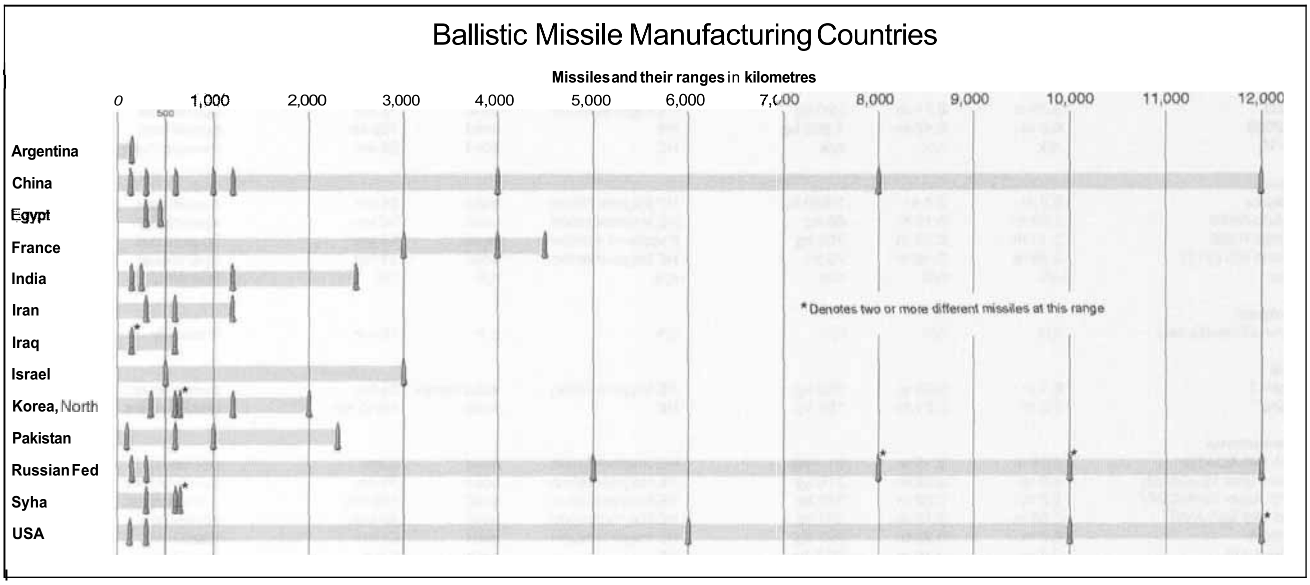
AIR-LAUNCHED CRUISE MISSILES, ASM AND NUCLEAR BOMBS

Missile name and designation	Length	Diameter	Launch weight	Payload	Propulsion	Range	Status	In-sewice
People's Republic of China								
CAS-1 (C-601/C-611) (YJ-6/62)	7.36 m	0.76 m	2,440 kg	single HE	liquid	110/200 km	operational	1982
HY-4	7.36 m	0.76 m	2,000 kg	single HE	turbojet	150 km	operational	1990
YJ-1 (C-801)	4.65 m	0.36 m	655 kg	single HE	solid	50/70 km	operational	1989
YJ-2 (C-802)	5.3 m	0.36 m	555 kg	single HE	turbojet	130/180 km	operational	1998
YJ-16 (C-101)	7.5 m	0.54 m	1,850 kg	single HE	ramjet	45 km	operational	1988
G701	2.5 m	n/k	100 kg	single HE	solid	15 km	operational	1998
HN-1	6.4 m	0.5 m	1,200 kg	single HE or nuclear	turbojet	650 km	operational	1996
HN-2	6.4 m	0.7 m	1,400 kg	single HE or nuclear	turbofan	1,800 km	development	2002
HN-3	6.4 m	0.75 m	1,800 kg	single HE or nuclear	turbofan	3,000 km	development	2005
France								
AM 39 Exocet	4.69 m	0.35 m	670 kg	single HE	solid	70 km	operational	1979
ASMP	5.38 m	0.38 m	860 kg	single 300 kT	ramjet	250 km	operational	1986
APACHE AP	5.1 m	0.63 × 0.48 m	1,230 kg	single HE/ submunitions	turbojet	140 km	operational	2001
APACHE SCALP-EG/Storm Shadow	5.1 m	0.63 × 0.48 m	1,300 kg	single HE	turbojet	250-400 km	development	2002
ASMP-A	5.6 m	n/k	950 kg	single 300 kT	ramjet	500 km	development	2008
Germany								
AS 34 Kormoran 1	4.4 m	0.34 m	600 kg	single HE	solid	30 km	operational	1977
AS 34 Kormoran 2	4.4 m	0.34 m	630 kg	single HE	solid	35 km	operational	1991
Taurus KEPD-150	4.6 m	0.63/0.32 m	1,060 kg	single HE	turbojet	150 km	development	2005
KEPD-350	5.1 m	0.63/0.32 m	1,400 kg	single HE	turbojet	350 km	development	2002
Taurus 350A/P	5.1 m	0.63/0.32 m	1,090 kg	single HE	turbojet	200 km	develooment	2002
Israel								
Gabriel 3AS	3.85 m	0.34 m	560 kg	single HE	solid	35 km	operational	1982
Gabriel 4LR	4.7 m	0.44 m	960 kg	single HE	turbojet	200 km	operational	1992
AGM-142 Popeye 1	4.82 m	0.53 m	1,360 kg	single HE	solid	80 or 90 km	operational	1990
Popeye 2	4.0 m	0.53 m	1,130 kg	single HE	solid	75 km	operational	1995
Italy								
Marte 2	4.8 m	0.32 m	340 kg	single HE	solid	25 km	operational	1987
Marte 2A	3.79 m	0.32 m	269 kg	single HE	solid	30 km	development	2002
Marte 2S	3.8 m	0.32 m	324 kg	single HE	solid	25 km	development	2002
Japan								
ASM-1	4.0 m	0.34 m	600 kg	single HE	solid	50 km	operational	1980
ASM-1C	4.0 m	0.35 m	600 kg	single HE	solid	65 km	operational	1991
ASM-2	4.1 m	0.35 m	520 kg	single HE	turbojet	100 km	ooerational	1993
Noway								
Penguin Mk 2 Mod 7	3.0 m	0.28 m	385 kg	single HE	solid	35 km	operational	1994
Penguin Mk 3	3.2 m	0.28 m	370 kg	single HE	solid	55 km	operational	1989
NSM	3.95 m	0.69 m	412 kg	single HE	solid	170 km	development	2007
Russian Federation								
AS-4 'Kitchen'	11.67 m	0.92 m	5,780-6,000 kg	single HE/350 kT	liquid	310-400 km	operational	1965
AS-6 'Kingfish'	10.56 m	0.92 m	4,500 kg	single HE/350 kT	solid	400 km	operational	1969
AS-13 'Kingbolt'	5.1 m	0.38 m	790 kg	single HE	solid	40 km	operational	1980
AS-15A 'Kent'	6.04 m	0.514 m	1,210 kg	single 200-250 kT	turbofan	2,500 km	operational	1984
AS-15B/C 'Kent'	6.04 m	0.56 m	1,500 kg	single HE/200-250kT/submunitions	turbofan	3,000 km	operational	1987
AS16 'Kickback'	4.78 m	0.46 m	1,100 kg	single HE/350 kT	solid	150 km	operational	1960
Kh-15C	4.78 m	0.46 m	1,200 kg	single HE	solid	150 kg	operational	1988
AS17 'Krypton' (Kh-31A)	4.7/5.23 m	0.36 m	610/700 kg	single HE	ramjet	70-100 km	operational	1989
AS-17 'Krypton' (Kh-31P)	4.7/5.23 m	0.36 m	599/625 kg	single HE	ramjet	110/200 km	operational	1988
AS-18 'Kazoo'	5.1 m	0.38 m	850 kg	single HE	turbojet	120 km	operational	1991
Kh-59ME	5.6 m	0.38 m	920 kg	single HE	turbojet	200 km	development	2002
Kh-59MK	5.7 m	0.42 m	930 kg	single HE	turbojet	285 km	development	2002
AS-X-19 'Koala'	10.5 m	1.2 m	2,800 kg	single nuclear/HE	turbofan	3,000 km	terminated	–
AS-20 'Kayak'	3.75 m	0.42 m	480 kg	single HE	turbofan	130/300 km	operational	1994
Kh-41 (Moskit)	9.74 m	0.76 m	4,500 kg	single HE	ramjet	250 km	development	2003
Kh-101	7.45 m	n/k	2,400 kg	single HE	turbofan	3,000 km	development	2002
3M55	8.3 m	0.67 m	2,550 kg	single HE	ramjet	500 km	development	2003
South Africa								
Raptor 2	n/k	0.36 m	1,200 kg	single HE	solid	120 km	development	2002
IMUPSOW	4.92 m	n/k	1,200 kg	single HE	turbojet	150 km	development	2003
Torgos	4.86 m	n/k	980 kg	single HE	turbojet	300 km	develooment	2005
Sweden								
RBS-15F Mk 1	4.35 m	0.5 m	598 kg	single HE	turbofan	100 km	operational	1989
RBS-15F Mk 2	4.35 m	0.5 m	630 kg	single HE	turbofan	150 km	development	2002
Taiwan								
Hsuing Feng 2	3.9 m	0.34 m	520 kg	single HE	turbojet	80 km	operational	1995

Missile name and designation	Length	Diameter	Launch weight	Payload	Propulsion	Range	Status	In-service
UK								
Sea Eagle	4.14 m	0.4 m	600 kg	single HE	turbojet	110 km	operational	1985
Hakim PGM-500	3.6 m	0.35 m	300 kg	single HE	solid	50 km	operational	1992
Hakim PGM-2000	4.6 m	0.43 m	1,115 kg	single HE	solid	50 km	operational	1992
USA								
AGM-84 Harpoon	3.85 m	0.34 m	556 kg	single HE	turbofan	120 km	operational	1977
AGM-84E SLAM	4.5 m	0.34 m	628 kg	single HE	turbofan	95 km	operational	1991
AGM-84H SLAM-ER	4.37 m	0.34 m	635 kg	single HE	turbofan	280 km	operational	1997
AGM-866 ALCM	6.32 m	0.69 m	1,458 kg	single 200 kT	turbofan	2,500 krn	operational	1982
AGM-86C/D CALCM	6.32 m	0.69 m	1,750/1,950 kg	single HE	turbofan	950 or 1,200 krn	operational	1988
AGM-129 ACM	6.35 m	0.64 m	1,590 kg	single selectable 5 -200 kT single HE	turbofan	2,500 krn	operational	1991
AGM-130	3.94 m	0.46 m	1,323 kg	single HE	solid	45 krn	operational	1992
AGM-158 JASSM	4.26 m	0.55/0.45 m	1,023 kg	single HE	turbojet	500 krn	development	2003
Nuclear Bombs								
USA								
657	3.0 m	0.38 m	230 kg	single 5-10 kT	–	–	operational	1964
661	3.6 m	0.34 m	315-325 ko	single 10 kT, 100 kT, 500 kT	–	–	operational	1967
B-61 Mod II	3.68 m	0.34 m	558 kg	single 100 to 500 kT	–	–	operational	1997
683	3.66 m	0.46 m	1,088 kg	single 1-2 MT	–	–	operational	1984

Ballistic Missile Capabilities, Manufacturing Countries

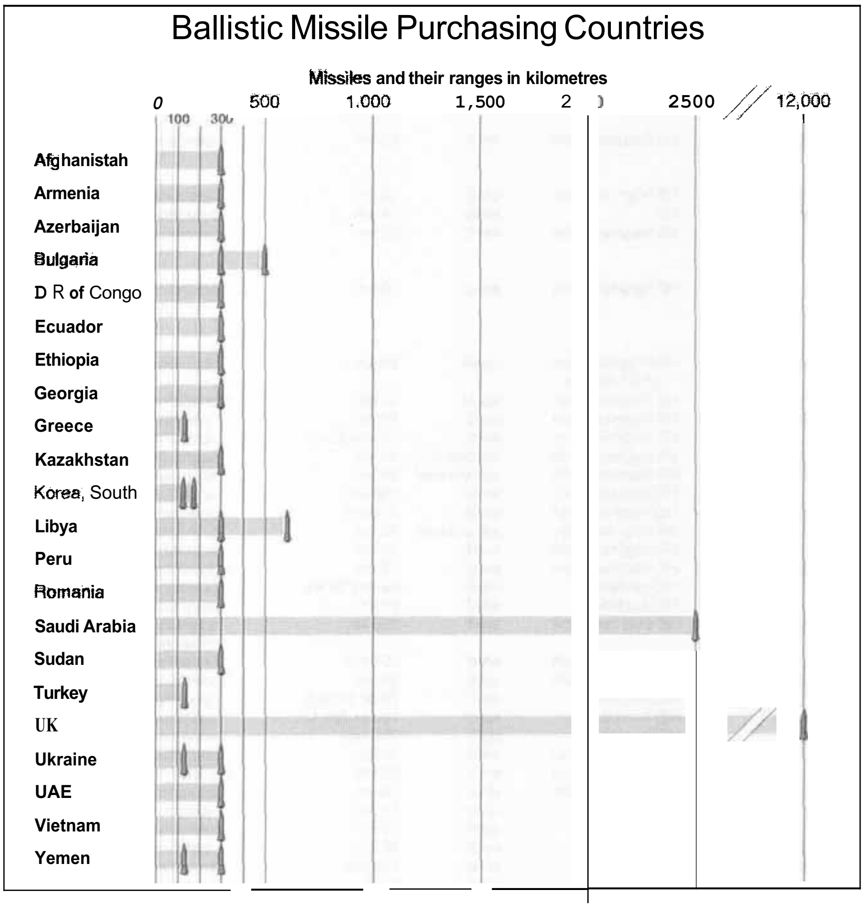
This graph lists the countries that have developed, manufactured and put into service land-based or submarine-launched ballistic missiles. Some countries have built their missiles using components or assemblies supplied by others, carried out final tests and then flown the missiles. The availability of a single missile has been used as the entry point for operational use in this table. The markers in the table indicate a ballistic missile maximum range capability.



Ballistic Missile Manufacturing Countries ***2002***/0121653

Ballistic Missile Capabilities, Purchasing Countries

This graph lists the countries that are reported to have purchased land-based or submarine-launched ballistic missiles, and have put these missiles into service.



Ballistic Missile Purchasing Countries
2002/0121654

DEFENSIVE WEAPONS TABLES

LAND-BASED THEATRE DEFENCE WEAPONS

System	Length	Body diameter	Launch weight	Warhead	Propulsion	Range	Status	In-service
People's Republic of China								
HQ-2	10.84 m	0.5 m	2,326 kg	HE fragmentation	liquid	35 km	operational	1967
CSA-N-2 (HQ-61)	3.99 m	0.29 m	320 kg	HE continuous rod	solid	10 km	operational	1991
FM-80 (HQ-7)	2.9 m	0.15 m	84.5 kg	HE fragmentation	solid	12 km	operational	1991
FM-90	3.12 m	0.16 m	100 kg	HE	solid	15 km	operational	1998
KS-1/1A	5.6 m	0.4 m	900 kg	HE fragmentation	solid	40 km (1), 50 km (1A)	operational	1996 (1), 2003 (1A)
LY-60	3.89 m	0.21 m	220 kg	HE fragmentation	solid	18 km	operational	1996
FT-2000	6.8 m	0.47 m	1,300 kg	HE	solid	100 km	operational	1998
HQ16	n/k	n/k	n/k	HE	solid	65 km	development	2003
France								
Masurca	8.6 m	0.4 m	2,090 kg	HE fragmentation	solid	55 km	operational	1967
Crotale R440	2.89 m	0.15 m	85 kg	HE fragmentation	solid	10 km	operational	1971
Crotale R460	3.12 m	0.16 m	100 kg	Focalised splinter	solid	15 km	operational	1980
Crotale NG (VT1)	2.29 m	0.16 m	73 kg	HE fragmentation	solid	11 km	operational	1992
Latex	n/k	n/k	n/k	n/k	n/k	n/k	feasibility	2005
Germany								
Ground-Based Laser	n/k	n/k	n/k	n/k	n/k	10 km	feasibility	2005
India								
Akash 1	6.1 m	0.34 m	650 kg	HE fragmentation	solid/ramjet	35 km	development	2002
Trishul	3.2 m	0.21 m	125 kg	HE	solid	10-15 km	development	2003
International								
MIM-146 ADATS	2.05 m	0.15 m	51.4 kg	HE fragmentation	solid	8 km	operational	1988
FSAF Aster 15 (SAAM)	4.2 m	0.32 m	310 kg	HE fragmentation	solid	30 km	development	2003
FSAF Aster 30 (SAMP/T)	5.2 m	0.38 m	510 kg	HE fragmentation	solid	100 km	development	2005
MIM-120 NASAMS	3.65 m	0.18 m	157 kg	HE fragmentation	solid	35 km	operational / feasibility	1996
ASAM-1	3.7 m	0.23 m	227 kg	HE fragmentation	solid	45 km		2003
Roland 1/2	2.4 m	0.16 m	66.5 kg	HE	solid	6 km	operational	1978
Roland 3	2.4 m	0.16 m	75.0 kg	HE	solid	8 km	operational	1988
TRIFOM	2.73 m	0.22 m	140 kg	HE	turbojet	60 km	development	2003
VL-MICA	3.1 m	0.16 m	112 kg	HE	solid	15 km	development	2004
Iran								
Sayyed-1	n/k	n/k	n/k	HE	solid	60 km	operational	1999
Iraq								
FAW-1	4.0 m	0.29 m	300 kg	HE fragmentation	solid	8 km	unknown	–
Israel								
ADAMS/Relampago/Defender	2.17 m	0.17 m	98 kg	HE fragmentation	solid	10 km	development	2003
Arrow 2	6.3 m	0.8 m	2,500 kg	HE fragmentation	solid	100 km	operational	2000
LAHAT	1.2 m	0.1 m	20 kg	HE	solid	5 km	development	2002
Derby	3.62 m	0.16 m	118 kg	HE	solid	n/k	development	2004
Italy								
Aspide (Spada)	3.7 m	0.2 m	220 kg	HE fragmentation	solid	15 km	operational	1978
Aspide 2000	3.7 m	0.203/ 0.234 m	225 kg	HE fragmentation	solid	25 km	operational	1998
Japan								
TanSAM 1 (Type 81)	2.7 m	0.16 m	100 kg	HE fragmentation	solid	10 km	operational	1981
TanSAM 1 kai	2.7 m	0.16 m	105 kg	HE	solid	14 km	operational	1997
TanSAM 2 (Chu-SAM)	n/k	n/k	n/k	HE fragmentation	solid	35 km	development	2004
South Korea								
Chun-Ma	2.17 m	0.15 m	70 kg	HE fragmentation	solid	10 km	operational	2001
Russian Federation								
SA-2E 'Guideline'	11.2 m	0.5 m	2,450 kg	HE fragmentation/ 25 kT nuclear	liquid	43 km	operational	1967
SA-2F 'Guideline'	10.8 m	0.5 m	2.287 kg	HE fragmentation	liquid	35 km	operational	1970
SA-3A 'Goa'	6.1 m	0.37 m	946 kg	HE fragmentation	solid	22 km	operational	1961
SA-3B/C 'Goa'	6.1 m	0.37 m	950 kg	HE fragmentation	solid	18 km/28 km	operational	1964/1987
SA-4A 'Ganef'	8.8 m	0.86 m	2,500 kg	HE fragmentation	solid/ramjet	55 km	operational	1967
SA-4B 'Ganef'	8.4 m	0.86 m	2,500 kg	HE fragmentation	solid/ramjet	50 km	operational	1973
SA-5A/B/C 'Gammon'	10.6 m	0.86 m	2,800 kg	HE/nuclear 25 kT	solid	150 km	operational	1963
SA-5 D 'Gammon'	10.6 m	0.86 m	2,800 kg	HE/nuclear 25 kT	solid	300 km	operational	1990
SA-6 'Gainful'	5.8 m	0.34 m	600 kg	HE fragmentation	solid/ramjet	25 km	operational	1970
SA-8A 'Gecko'	3.15 m	0.21 m	126 kg	HE fragmentation	solid	10 km	operational	1974
SA-8B 'Gecko'	3.15 m	0.21 m	126 kg	HE fragmentation	solid	15 km	operational	1980
SA-10A/B 'Grumble' (5V55)	7.11 m	0.45 m	1,590 kg	HE/nuclear	solid	45 km/75 km	operational	1980/1982
SA-1OC 'Grumble'	7.25 m	0.45 m	1,625 kg	HE/nuclear	solid	90 km	operational	1985
SA-1OD 'Grumble' (48N6)	7.5 m	0.52 m	1,800 kg	HE fragmentation	solid	150 km	operational/ development	1992
SA-20 'Grumble'	7.5 m	0.52 m	1,840 kg	HE fragmentation	solid	200 km	operational	2000
SA-11 'Gadfly'	5.55 m	0.4 m	650 kg	HE fragmentation	solid	35 km	operational	1979
SA-12A 'Gladiator'	7.0 m	0.72 m	2,500 kg	HE/nuclear	solid	75 or 100 km	operational	1987
SA-12B 'Giant'	8.5 m	0.9 m	4,600 kg	HE/nuclear	solid	100 or 200 km	operational	1990
Antey 2500	8.5 m	0.9 m	4,600 kg	HE/nuclear	solid	200 km	operational	1998
SA-15 'Gauntlet'	2.9 m	0.24 m	167 kg	HE fragmentation	solid	12 km	operational	1991
SA-17 'Grizzly'	5.5 m	0.4 m	715 kg	HE fragmentation	solid	50 km	operational	1994
SA-19 'Grison'	2.63 m	0.15/0.08 m	42 kg	HE fragmentation	solid	10 km	operational	1988
SA-19 Pantsir-Sl (9M335)	3.2 m	0.17 m	65 kg	HE rod	solid	12 km	operational	1999
SA-19 Pantsir-S1 (57E6Y)	3.2 m	0.17 m	74 kg	HE	solid	20 km	operational	2002
Trieumf 9M96	4.75 m	0.24 m	333 kg	HE	solid	40 km	operational	2002
Trieumf 9M96/2	5.65 m	0.24 m	420 kg	HE	solid	120 km	development	2002
Sosna-R	2.2 m	0.13/0.07 m	25 kg	HE	solid	8 km	development	2003

System	Length	Body diameter	Launch weight	Warhead	Propulsion	Range	Status	In-service
South Africa								
SAHV-3	3.13 m	0.18 m	115 kg	HE fragmentation	solid	12 km	operational	1994
SAHV-IRS	3.36 m	0.18 m	120 kg	HE fragmentation	solid	10 km	operational	1998
SAHV-RS	3.6 m	0.18 m	137 kg	HE fragmentation	solid	13 km	development	2003
Sweden								
BAMSE (RBS-23)	2.6 m	0.21/0.11 m	85 kg	HE fragmentation	solid	15 km	development	2003
Taiwan								
Sky Bow 1	5.3 m	0.41 m	914 kg	HE fragmentation	solid	50 km	operational	1988
Sky Bow 2	8.1 m	0.41 m	1,115 kg	HE fragmentation	solid	80 km	operational	1993
Sky Bow 3	n/k	n/k	n/k	n/k	solid	150 km	development	2003
Tien Chien 2	3.6 m	0.19 m	183 kg	HE	solid	40 km	development	2004
UK								
Rapier 2000 (Jernas)	2.24 m	0.13 m	43 kg	HE fragmentation/SAP	solid	7 km	operational	1996
USA								
THAAD	6.17 m	0.37 m	600 kg	impact	solid	250 km	development	2008
PAC-3 (ERINT)	5.2 m	0.26 m	315 kg	HE fragmentation	solid	20 km	development	2002
Hypervelocity Gun	n/k	n/k	n/k	impact 6 kg	n/k	50 km	demonstrator	2010
MiM-14 Nike Hercules	12.14 m	0.54 m	4,858 kg	HE/nuclear	solid	145 km	operational	1958
MIM-23A HAWK	5.08 m	0.37 m	584 kg	HE fragmentation	solid	25 km	operational	1960
MIM-23B/C/D/E/F HAWK	5.03 m	0.37 m	638 kg	HE fragmentation	solid	35 km	operational	1973
MIM-104 Patriot	5.2 m	0.41 m	914 kg	HE fragmentation	solid	70 km	operational	1984
EFOG-M	1.94 m	0.17 m	51.3 kg	HE	solid	15 km	terminated	—
Airborne Laser (YAL-1)	n/k	n/k	n/k	COIL	n/k	400 km	development	2010
SWORD	2.0 m	0.09 m	23 kg	rod	solid	10 km	development	2006
MALI	2.5 m	0.18 m	50 kg	HE	turbojet	100-350 km	development	2008
CKEM	1.2 m	0.13	23 kg	rod	solid	8 km	development	2015
Ground-Based Laser (THEL)	n/k	n/k	n/k	n/k	n/k	10 km	development	2005

SEA-BASED THEATRE DEFENCE WEAPONS

System	Length	Body diameter	Launch weight	Warhead	Propulsion	Range	Status	In-service
People's Republic of China								
CSA-N-2 (SD-1)	3.99 m	0.29 m	320 kg	HE continuous rod	solid	10 km	operational	1992
FM-80 (HQ-7)	2.9 m	0.15 m	84.5 kg	HE fragmentation	solid	12 km	operational	1992
FM-90	3.12 m	0.16 m	100 kg	HE	solid	15 km	operational	1998
LY-60	3.89 m	0.21 m	220 kg	HE fragmentation	solid	18 km	operational	1999
France								
Crotele R440	2.89 m	0.15 m	85 kg	HE fragmentation	solid	10 km	operational	1971
India								
Akash	5.8 m	0.34 m	650 kg	HE fragmentation	solid/ramjet	25 km	development	2002
Trishui	3.2 m	0.21 m	125 kg	HE	solid	10 to 15 km	development	2003
International								
FSAF Aster 15 (SAAM)	4.2 m	0.32 m	310 kg	HE fragmentation	solid	30 km	development	2002
FSAF Aster 30 (SAMP/N)	5.2 m	0.38 m	510 kg	HE fragmentation	solid	100 km	development	2005
RIM-116 RAM	2.79 m	0.13 m	73.5 kg	HE fragmentation	solid	10 km	operational	1993
TRITON	2.0 m	0.22 m	120 kg	HE	solid	15 km	development	2005
VL-MICA	3.1 m	0.16 m	112 kg	HE	solid	15 km	development	2004
Israel								
Barak	2.17 m	0.17 m	98 kg	HE fragmentation	solid	12 km	operational	1994
Derby	3.62 m	0.16 m	118 kg	HE	solid	n/k	development	2004
Italy								
Aspide (Aibatros)	3.7 m	0.2 m	220 kg	HE fragmentation	solid	15 km	operational	1978
Russian Federation								
SA-N-1A 'Goa'	6.1 m	0.37 m	946 kg	HE fragmentation	solid	30 km	operational	1961
SA-N-1B 'Goa'	6.1 m	0.37 m	950 kg	HE fragmentation	solid	25 or 28 km	Operational	1964
SA-N3A 'Goblet'	6.1 m	0.6 m	845 kg	HE fragmentation	solid	30 km	operational	1967
SA-N-3B 'Goblet'	6.1 m	0.6 m	845 kg	HE fragmentation	solid	55 km	operational	1970
SA-N-4A 'Gecko'	3.1 m	0.21 m	130 kg	HE fragmentation	solid	10 km	operational	1968
SA-N-4B 'Gecko'	3.1 m	0.21 m	130 kg	HE fragmentation	solid	15 km	operational	1980
SA-N-6 'Grumble'	7.25 m	0.45 m	1,500 kg	HE/nuclear	solid	45/90 km	operational	1982
SA-N-7 'Gadfly'	5.55 m	0.4 m	650 kg	HE fragmentation	solid	35 km	operational	1981
SA-N-9 'Gauntlet'	2.9 m	0.24 m	167 kg	HE fragmentation	solid	12 km	operational	1984
SA-N-11 'Grison'	2.63 m	0.15/0.08 m	42 kg	HE fragmentation	solid	10 km	operational	1988

System	Length	Body diameter	Launch weight	Warhead	Propulsion	Range	Status	In-service
SA-N-11 Pantsir-S1	2.63 m	0.15/0.08 m	65 kg	HE	solid	12 km	development	2004
SA-N-12 'Grizzly'	5.5 m	0.4 m	715 kg	HE fragmentation	solid	42 km	operational	1999
Trieumf 9M96	4.75 m	0.24 m	333 kg	HE	solid	40 km	development	2003
Trieumf 9M96/2	5.65 m	0.24 m	420 kg	HE	solid	120 km	development	2004
Sosna-R	2.2 m	0.13/0.07 m	25 kg	HE	solid	8 km	development	2003
South Africa								
Umkhonto	3.3 m	0.18 m	125 kg	HE	solid	12 km	development	2004
UK								
Sea Dart GWS 30	4.36 m	0.42 m	550 kg	HE continuous rod/ fragmentation	solid/ramjet	40 km	operational	1973
Seawolf GWS 25	2.0 m	0.18 m	82 kg	HE fragmentation	solid	6 km	operational	1973
Seawolf GWS 26 Mod 1 (VLS)	3.3 m	0.18 m	140 kg	HE fragmentation	solid	7 km	operational	1991
USA								
Hypervelocity Gun	n/k	n/k	n/k	impact 6 kg	n/k	50 km	demonstrator	2010
RIM-7E Sea Sparrow	3.66 m	0.2 m	227 kg	HE continuous rod	solid	15 km	operational	1973
RIM-7H Sea Sparrow	3.66 m	0.2 m	205 kg	HE continuous rod	solid	15 km	operational	1967
RIM-7M/P Sea Sparrow	3.66 m	0.2 m	231 kg	HE fragmentation	solid	15 km	operational	1983/91
RIM-7R Sea Sparrow	3.66 m	0.2 m	232 kg	HE fragmentation	solid	15 km	operational	1997
RIM-162 (ESSM)	3.7 m	0.25 m	282 kg	HE fragmentation	solid	30 km	development	2003
RIM-66 Standard SM-1MR	4.48 m	0.34 m	617 kg	HE fragmentation	solid	40 km	operational	1968
RIM-66 Standard SM-2MR	4.72 m	0.34 m	708 kg	HE fragmentation	solid	80 km	operational	1978
RIM-67 Standard SMZER	7.98 m	0.34 m	1,509 kg	HE fragmentation	solid	120 km	operational	1982
RIM-156A Standard SM-PER (block 4)	6.5 m	0.34 m	1.398 kg	HE fragmentation	solid	150 km	operational	2001
RIM-1566 Standard SM-PER (block 4A)	6.55 m	0.53/0.34 m	1,400 kg	HE fragmentation	solid	200 km	development	2007
Standard SM-3	6.6 m	0.53/0.34 m	1,505 kg	kill warhead	solid	1,200 km	development	2010
Ship-Based Laser	n/k	n/k	n/k	n/k	n/k	10 km	feasibility	2010

ANTI-SATELLITE WEAPONS (ASATs)

System	Length	Body diameter	Launch weight	Warhead	Propulsion	Range	Status	In-service
Russian Federation								
ASAT	35.0 m	3.0 m	182,000 kg	HE fragmentation 1,400 kg	liquid	LEO	operational	1971
USA								
ASM-135 ASAT	5.18 m	0.51 m	1,180 kg	MHV impact	solid	LEO	terminated	—
KE-ASAT	n/k	n/k	2,000 kg	45 kg KKV	solid	LEO	feasibility	2010

ANTI-BALLISTIC MISSILES (ABM)

Svstem	Length	Body diameter	Launch weight	Warhead	Propulsion	Range	Status	In-service
Russian Federation								
SH-11 'Gorgon'	19.8 m	2.57/1.97 m	33,000 kg	nuclear 10 kT	solid/liquid	350 km	operational	1986
SH-08 'Gazelle'	10.0 m	1.0 m	10,000 kg	nuclear 10 kT/HE	solid	80 km	operational	1984
USA								
GMD	17.5 m	1.01/0.8/ 0.7/0.8 m	14,820 kg	120 kg EKV	Solid	2,500 km	development	2007

Country	Offensive Weapons	Defensive Weapons
Afghanistan	SS-1 'Scud' (RF) FROG-7 (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF)
Albania	CSS-N-1 (FL-1) (PRC) CSSC-3 (HY-2) (PRC)	HQ-2 (PRC) SA-2 'Guideline' (RF)
Algeria	SSC-3 'Styx' (RF) FROG-7 (RF) SS-N-25 "Switchblade' (RF) AS-20 'Kayak' (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF) SA-N-4 'Gecko' (RF)
Angola	SS-N-2 'Styx' (RF) SSC-1B 'Sepal' (RF) FROG-7 (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF)
Argentina	MM 38/40 Exocet (France) (France) Alacran Gabriel (Israel)	Aspide (Italy) Sea Dart (UK) Roland (International)
Armenia	SS-1 'Scud' (RF)	
Australia	RGM-84 Harpoon (USA) AGM-142 Popeye (Israel) AGM-119 Penguin (Noway)	RIM-66/67 Standard (USA)
Azerbaiian	SS-1 'Scud' (RF) FROG-7 (RF) SS-N-2 'Styx' (RF) SA-5 variant (RF) AS-13 'Kingbolt' (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-4 'Ganef' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF)
Bahrain	MM 38/40 Exocet (France) RGM-84 Harpoon (USA)	Crotale (France) MIM-23 HAWK (USA)
Bangladesh	CSS-N-1 (FL-1) (PRC) CSSC-3 (HY-2) (PRC) Otomat (Int)	
Belarus	FROG-7 (RF) SS-21 'Scarab' (RF) AS-4 'Kitchen' (RF) AS-6 'Kingfish' (RF) AS-13 'Kingbolt' (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-4 'Ganef' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF) SA-10 'Grumble' (RF) SA-12 'Gladiator' (RF) SA-15 'Gauntlet' (RF)
Belgium	MM 38 Exocet (France)	RIM-7 Sea Sparrow (USA) MIM-23 HAWK (USA)
Brazil	MM 38/40 Exocet (France) RUR-5 ASROC (USA) Ikara (Australia) RGM-84 Harpoon (USA)	Albatros (Italy) Roland (International)
Brunei	MM 38 Exocet (France)	Rapier (UK)
Bulgaria	SS-1 'Scud' (RF) FROG-7 (RF) SS-N-2 'Styx' (RF) 58-23 'Spider' (RF) SSC-1B 'Sepal' (RF) SSC-3 'Styx' (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-4 'Ganef' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-10 'Grumble' (RF) SA-N-4 'Gecko' (RF)
Cameroon	MM 40 Exocet (France)	
Canada	RUR-5 ASROC (USA) RGM-84 Harpoon (USA)	RIM-66/67 Standard (USA) RIM-7 Sea Sparrow (USA) MIM-146 ADATS (joint programme)
Chile	MM 38 Exocet (France) Gabriel (Israel)	Crotale (France) Barak (Israel)
People's Republic of China	CSS-2 (DF-3) CSS-3 (DF-4) CSS-4 (DF-5) CSS-5 (DF-21) CSS-6 (M-9) CSS-7 (M-11) CSS-8 (M-7) CSS-9 (DF-31) CSS-N-1 (SY-1) CSS-N-2 (HY-1) SS-N-22 'Sunburn' (RF) CSSC-2 'Silkworm' (HY-1) CSSC-3 (HY-2) CSSC-6 (HY-3/C-301) CSSC-7 (HY-4) CSSC-8 (YJ-2/C-802) CSSN-1 (FL-1) CSS-N-3 (JL-1) CSS-N-4 (YJ-1/C-801) CSSC-5 (YJ-16 /C-101) CY-1 CAS-1 (C-601/611) AS-17 'Krypton' (RF) KR-1 (AS-17) (RF) Kh-59M (AS-18) (RF) C-701 HN-1 Nuclear bombs	HG-2 HQ-61 CSA-N-2 Crotale (France) SA-2 'Guideline' (RF) CSA-4/-5 (HG-7) SA-10 'Grumble' (RF) LY-60 KS-1 FT-2000 HQ-10 Laser Weapon SA-15 'Gauntlet' (RF) SA-N-7 'Gadfly' (RF)
Colombia	MM 40 Exocet (France)	
Democratic Reoublic of Congo (formerly Zaire)	SS-1 'Scud B' (RF)	
Croatia	SS-N-2 'Styx' (RF) RBS 15 (Sweden) SA-2 variant (RF)	SA-8 'Gecko' (RF) SA-10 'Grumble' (RF)
Cuba	SS-N-2 'Styx' (RF) SSC-3 'Styx' (RF) FROG-7 (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF) SA-N-4 'Gecko' (RF)
Cyprus	MM-40 Exocet (France)	SA-15 (RF)
Czech Republic		SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-4 'Ganef' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF) SA-10 'Grumble' (RF)
Denmark	RGM-84 Harpoon (USA)	RIM-7 Sea Sparrow (USA) MIM-23 HAWK (USA)
Ecuador	MM 38/40 Exocet (France) Gabriel 2 (Israel) SS-1 'Scud' (RF)	Aspide (Italy)
Egypt	Otomat 1 (International) SS-1 'Scud' (RF) CSSN-1 (FL-1) (PRC) FROG-7 (RF) SS-N-2 'Styx' (RF) CSSC-2 'Silkworm' (PRC) CSSC-3 (HY-2) (PRC) RGM-84 Harpoon (USA) Project T RUR-5 ASROC (USA)	Crotale (France) SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-6 'Gainful' (RF) RIM-7 Sparrow (USA) MIM-23 HAWK (USA)
Ethiopia	SS-N-2 'Styx' (RF) SS-1 'Scud B' (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-6 'Gainful' (RF)
Finland	RBS-15SF (Sweden) SS-N-2 'Styx' (RF)	SA-3 'Goa' (RF) SA-11 'Gadfly' (RF) Crotale NG (France)
France	MM 38, AM 39, SM 39 and MM 40 Exocet MSBS M-4 MSBS M-45 Malafon ASMP APACHE AP	RIM-66/67 Standard (USA) Crotale/Crotale NG MIM-23 HAWK (USA) Mascura 2 Roland Aster 15
Georgia	FROG-7 (RF) SS-1 'Scud' (RF) SS-N-2 'Styx' (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-4 'Ganef' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-E 'Gecko' (RF) SA-N-4 'Gecko' (RF)
Germany	MM 38 Exocet (France) RGM-84 Harpoon (USA) RUR-5 ASROC (USA) AS 34 Kormoran	MIM-104 Patriot (USA) RIM-66/67 Standard (USA) RIM-7 Sea Sparrow (USA) MIM-23 HAWK (USA) RIM-116 RAM (joint Programme) Roland (International)
Greece	MM 38 Exocer (France) RGM-84 Harpoon [USA) RUR-5 ASROC (USA) AGM-119 Penguin (Norway) MGM-140 ATACMS (USA) AGM-142 Popeye (Israel)	Crotale/Crotale NG (France) Aspide (Italy) RIM-7 Sea Sparrow (USA) MIM-14 Nike Hercules (USA) MIM-23 HAWK (USA) RIM-66/67 Standard (USA) SA-10 'Grumble' (RF)

Country	Offensive Weapons	Defensive Weapons
		SA-15 'Gauntlet' (RF) MIM-104 Patriot (USA) RIM-116 (International) SA-6 'Gainful' (RF)
Guinea-Bissau		SA-6 'Gainful' (RF) SA-8 'Gecko' (RF)
Hungary		SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-4 'Ganef' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF)
India	SSN-2 'Styx' (RF) SS-N-22 'Sunburn' (RF) SS-N-9 'Siren' (RF) Prithvi SS-150/SS-250 Sea Eagle (UK) Nuclear bomb Agni 1 Agni 2 SS-N-25 'Switchblade' (RF) SS-N-27 Club (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF) SA-10 'Grumble' (RF) SA-11 'Gadfly' (RF) SA-12 'Gladiator' (RF) SA-15 'Gauntlet' (RF) SA-19 'Grison' (RF) SA-N-1 'Goa' (RF) SA-N-4 'Gecko' (RF) SA-N-7 'Gadfly' (RF) SA-N-11 'Grison' (RF) Akash Barak (Israel)
Indonesia	MM 38 Exocet (France) RGM-84 Harpoon (USA)	Rapier (UK)
Iran	CSSC-2 'Silkworm' (PRC) SS-1 'Scud' (RF) 'Scud B variant (North Korea) 'Scud C' variant (North Korea) CSSC-3 (HY-2) (PRC) SSN-2 'Styx' (RF) SS-N-22 'Sunburn' (RF) Gabriel (Israel) CSSC-8 (YJ-2) (PRC) RGM-84 Harpoon (USA) CSS-N-4 (YJ-1) (PRC) Karus (C-801) Nazeat 4 to 10 Sea Killer Mk 2 (Italy) Tondar (C-802) MGM-52 Lance (USA) Shahab 3	RIM-66/67 Standard (USA) HQ-2 (PRC) SA-2 'Guideline' (RF) MIM-23 HAWK (USA) SA-5 'Gammon' (RF) Rapier (UK) FM-80 (PRC) SA-6 'Gainful' (RF) SA-10 'Grumble' (RF) Crotale variant Sayyed-1 SA-15 'Gauntlet' (RF)
Iraq	FAW 70/150 Otomat 1 (International) SS-1 'Scud' (RF) FROG-7 (RF) Layth Al Hussein CSSC-2 'Silkworm' (PRC) CSSC-3 (HY-2) (PRC) SS-N-2 'Styx' (RF) CSS-8 (M-7) (PRC) MM39 Exocet (France) AM39 Exocet (France)	Aspide (Italy) SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF) Roland (International)
Israel	Jericho 1 and 2 MGM-52 Lance (USA) Gabriel 2, 3, 4 RGM-84 Harpoon (USA) Keres Popeye 1/2	MIM-23 HAWK (USA) MIM-104 Patriot (USA) Barak Arrow 2
Italy	MGM-52 Lance (USA) Otomat 1/2 Marte 2 AS 34 Kormoran (Germany) MILAS	Aspide 1 (Spada) RIM-66/67 Standard (USA) RIM-7 Sea Sparrow (USA) MIM-23 HAWK (USA) MIM-14 Nike Hercules (USA)
Ivory Coast	MM 40 Exocet (France)	
Japan	SSM-1A/-1B RGM-84 Harpoon (USA) RUM-139 VL-ASROC (USA) RUR-5 ASROC (USA) ASM-1	MIM-104 Patriot (USA) RIM-66/67 Standard (USA) Tan-SAM (Type 81) RIM-7 Sea Sparrow (USA) MIM-14 Nike Hercules (USA) MIM-23 HAWK (USA)
Jordan		MIM-23 HAWK (USA) SA-8 'Gecko' (RF)
Kazakhstan	FROG-7 (RF) SS-1 'Scud' (RF) SS-21 'Scarab' (RF) SS-18 'Satan' (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF)

Country	Offensive Weapons	Defensive Weapons
	AS-4 'Kitchen' (RF) AS-13 'Kingbolt' (RF)	SA-8 'Gecko' (RF) SA-11 'Gadfly' (RF)
Kenya	Otomat Mk 2 (International) Gabriel 2 (Israel)	
Korea, North	SS-1 'Scud' (RF) 'Scud B' variant/Hwasong 5 FROG-7 (RF) SS-N-2 'Styx' (RF) SA-2 'Guideline' variant (RF) CSSC-2 'Silkworm' (PRC) CSSC-3 (HY-2) (PRC) 'Scud C' variant/Hwasong 6 'Scud D' variant/Hwasong 7 CSS-N-4 (YJ-!) (PRC) No-dong-1/-2	HQ-2 (PRC) SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-5 'Gammon' (RF)
Korea, South	NHK-1 Nike Hercules (USA) MM 38 Exocet (France) RGM-84 Harpoon (USA) RUR-5 ASROC (USA) MGM-140 ATACMS (USA) AGM-130 (USA) NHK-1 (Hyon Mu) AGM-142 (Israel)	RIM-7 Sea Sparrow (USA) RIM-66/67 Stanoard (USA) MIM-14 Nike Hercules (USA) MIM-23 HAWK (USA) Chun-Ma (Pegasus) MIM-104 Patriot (USA)
Kuwait	MM 40 Exocet (France) RGM-84 Harpoon (USA) Sea Skua (UK)	SA-8 'Gecko' (RF) MIM-23 HAWK (USA) MIM-104 Patriot (USA) Aspide 1 (Italy) RIM-7 Sparrow (USA)
Laos		SA-3 'Goa' (RF)
Libya	SS-1 'Scud' (RF) Marte 1 (Italy) FROG-7 (RF) Otomat 1 (International) SS-N-2/SSC-3 'Styx' (RF) 'Scud C' variant (North Korea)	Crotale (France) Aspide (Italy) SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF)
Lithuania		SA-N-4 'Gecko' (RF)
Malaysia	MM 38 Exocet (France) RGM-84 Harpoon (USA) Otomat 1 (International)	Rapier (UK)
Mali		SA-3 'Goa' (RF)
Mexico	RUR-5 ASROC (USA) Otomat 1 (International)	
Mongolia		SA-2 'Guideline' (RF)
Morocco	MM 38/40 Exocet (France) Otomat 1 (International)	Aspide (Italy)
Mozambique		SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF)
Netherlands	RGM-84 Harpoon (USA)	MIM-104 Patriot (USA) RIM-66/67 Standard (USA) RIM-7 Sea Sparrow (USA) MIM-23 HAWK (USA)
Nicaragua		SA-8 'Gecko' (RF)
Nigeria	MM 38 Exocet (France) Otomat (Italy)	Aspide (Italy) Roland (International)
Norway	AGM-119 Penguin 1/2/3	RIM-7 Sea Sparrow (USA) MIM-23 HAWK (USA) MIM-120 NASAM
Oman	MM 38/40 Exocet (France) RGM-84 Harpoon (USA)	Rapier (UK) Crotale NG (France)
Pakistan	Hatf 5 (Ghauri 1/2) CSSC-3 (HY-2) (PRC) UGM/RGM-84 Harpoon (USA) RUR-5 ASROC (USA) Hatf 1/1A/1B Hatf 2A CSS-7 (M-11) (PRC) MM 40 Exocet (France) SS-1 'Scud' (RF) Hatf 4 (Shaheen 1) Nuclear bomb	HQ-2 (PRC) Crotale (France) SA-2 'Guideline' (RF) LY-60 (PRC)
Peru	MM 38 Exocet (France) Otomat 1/2 (International) SS-1 'Scud' (RF) Marte 1 (Italy)	Aspide (Italy) SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-15 'Gauntlet' (RF) SA-19 'Grison' (RF)
Poland	FROG-7 (RF) SSN-2 'Styx' (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF)

Country	Offensive Weapons	Defensive Weapons
	SSC-3 'Styx' (RF) RGM-84 Harpoon (USA)	SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF) SA-10 'Grumble' (RF) SA-11 'Gadfly' (RF) SA-N-1 'Goa' (RF) SA-N-4 'Gecko' (RF)
Portugal	RGM-84 Harpoon (USA)	RIM-66 Standard (USA) RIM-7 Sea Sparrow (USA) MIM-23 HAWK (USA)
Qatar	MM 40 Exocet (France)	Roland (International)
Romania	SS-1 'Scud' (RF) FROG-7 (RF) SS-N-2 'Styx' (RF)	SA-2 'Guideline' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF) SA-N-7 'Gadfly' (RF)
Russian Federation	SS-18 'Satan' SS-19 'Stiletto' SS-21 'Scarab A/B' SS-24 'Scalpel' SS-25 'Sickle' SS-N-2 'Styx' SS-N-8 'Sawfly' SS-N-9 'Siren' SS-N-12 'Sandbox' SS-N-14 'Silex' SS-N-15 'Starfish' SSN-16 'Stallion' SS-N-18 'Stingray' SSN-19 'Shipwreck' SS-N-20 'Sturgeon' SS-N-21 'Sampson' SSN-22 'Sunburn' SS-N-23 'Skiff' SS-N-25 SSN-29 Medvedka FROG-7 AS-4 'Kitchen' Nuclear bombs AS-15 'Kent' AS16 'Kickback' AS-17 'Krypton' AS-18 'Kazoo' AS-20 'Kayak'	SA-2 'Guideline' SA-3 'Goa' SA-5 'Gammon' SA-6 'Gainful' SA-8 'Gecko' SA-10 'Grumble' SA-11 'Gadfly' SA-12A 'Gladiator' SA-12B 'Giant' SA-15 'Gauntlet' SA-17 'Grizzly' SA-19 'Grison' SA-N-1 'Goa' SA-N-3 'Goblet' SA-N-4 'Gecko' SA-N-6 'Grumble' SA-N-7 'Gadfly' SA-NB 'Gauntlet' SA-N-11 'Grison' SA-N-12 'Grizzly' S-400 SH-08 'Gazelle' SH-11 'Gorgon' Anti-Satellite System
Saudi Arabia	CSS-2 (PRC) Otomat Mk 2 (International) RGM-84 Harpoon (USA) MM 40 Exocet (France)	Crotale (France) MIM-23 HAWK (USA) MIM-104 Patriot (USA)
Singapore	RGM-84 Harpoon (USA) Gabriel 1 (Israel)	MIM-23 HAWK (USA) Rapier (UK) Barak (Israel)
Slovakia		SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-4 'Ganef' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF)
Somalia	SSN-2 'Styx' (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-6 'Gainful' (RF)
South Africa	Skorpioen (Gabriel 2) (Israel) Raptor-1	Cactus-Crotale (France) SA-8 'Gecko' (RF) SAHV-3/-IR
Spain	RUR-5 ASROC (USA) RGM-84 Harpoon (USA) SM-39 Exocet	Aspide Mk I (Italy) RIM-7 Sea Sparrow (USA) MIM-23 HAWK (USA) RIM-66 Standard (USA) Roland (International) Spada 2000 (Italy)
Sweden	RBS-15 Penguin (Noway)	Rb-77 (MIM-23 HAWK) (USA)
Sudan	CSSC-2 'Silkworm' (PRC) SS-1 'Scud B'	SA-2 'Guideline' (RF)
Syria	SS-1 'Scud' (RF) 'Scud B' variant (North Korea) SS-21 'Scarab' (RF) FROG-7 (RF) SS-N-2 'Styx' (RF) SSC-1B 'Sepal' (RF) SSC-3 'Styx' (RF) 'Scud C' variant (North Korea) 'Scud D' variant (North Korea) CSS-6 (M-9) (PRC)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF) SA-10 'Grumble' (RF) SA-11 'Gadfly' (RF)
Taiwan	Green Bee (Ching Feng) Hsiung Feng 1 and 2	RIM-66/67 Standard (USA) MIM-14 Nike Hercules (USA)

Country	Offensive Weapons	Defensive Weapons
	RUR-5 ASROC (USA) RGM-84 Harpoon (USA) MM-40 Exocet (France) Tien Chi	MIM-23 HAWK (USA) Sky Bow 1 and 2 Crotale (France) MIM-104 Patriot (USA)
Tanzania		SA-3 'Goa' (RF) SA-6 'Gainful' (RF)
Thailand	CSSN-4 (PRC) CSSN-1 (PRC) Gabriel 1 (Israel) RGM-84 Harpoon (USA) MM 38 Exocet (France)' RUR-5 ASROC (USA)	Aspide (Italy) ADATS (Intnl)
Tunisia	MM 40 Exocet (France) SS-N-2 'Styx' (RF)	
Turkey	RGM-84 Harpoon (USA) RUR-5 ASROC (USA) MGM-140 ATACMS (USA) AGM-142 Popeye (Israel)	RIM-7 Sea Sparrow (USA) MIM-14 Nike Hercules (USA) Aspide (Italy) Rapier (UK)
UK	MM 38 Exocet (France) RGM-84 Harpoon (USA) UGM-133 Trident (USA) UGM-109 Tomahawk (USA)	Sea Dart Seawolf Rapier 2000
Ukraine	SS-1 'Scud' (RF) SS-21 'Scarab' (RF) SS-N-2 'Styx' (RF) SS-N-3 'Shaddock/Sepal' (RF) SS-N-9 'Siren' (RF) SS-N-12 'Sandbox' (RF) SS-N-14 'Silex' (RF) SSN-19 'Shipwreck' (RF) SS-N-22 'Sunburn' (RF) FROG-7 (RF) AS-4 'Kitchen' (RF) AS-6 'Kingfish' (RF) AS-13 'Kingbolt' (RF) AS-15 'Kent' (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-4 'Ganef' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF) SA-10 'Grumble' (RF) SA-11 'Gadfly' (RF) SA-12A 'Gladiator' (RF) SA-15 'Gauntlet' SA-19 'Grison' (RF) SA-N-1 'Goa' (RF) SA-N-4 'Gecko' (RF) SA-N-6 'Grumble' (RF) SA-N-7 'Gadfly' (RF) SA-N-9 'Gauntlet' (RF) SA-N-11 'Grison' (RF)
United Arab Emirates	MM 40 Exocet (France) 'Scud B' variant (NK) Hakim PGM-500/-2000 (UK) HY-2 (PRC)	Crotale (France) MIM-23 HAWK (USA) Rapier (UK) RIM-66 Standard (USA) SA-19 'Grison' (RF)
USA	MGM-140 ATACMS LGM-30G Minuteman III LGM-118 Peacekeeper UGM-96 Trident C-4 UGM-133 Trident D5 RGM/UGM-109 Tomahawk AGM/RGM/UGM-84 Harpoon AGM-84E/H SLAM/-ER AGM-86 ALCM AGM-119 Penguin (Norway) AGM-129 (ACM) AGM-130 AGM-142 Popeye (Israel) B57 Nuclear Bomb B61 Nuclear Bomb B83 Nuclear Bomb	RIM-7 Sea Sparrow MIM-23 HAWK RIM-66/67/156 Standard MIM-104 Patriot RIM-116 RAM (joint Programme)
Venezuela	Otomat (International) RGM/AGM-84 Harpoon (USA) Marte 1 (Italy)	Aspide (Italy) Roland (International) Barak (Israel)
Vietnam	SS-1 'Scud' (RF) SS-N-2 'Styx' (RF) Scud C variant (North Korea)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-6 'Gainful' (RF)
Yemen	SS-1 'Scud' (RF) C-801 (YJ-1) (PRC) FROG-7 (RF) SS-N-2/SSC-3 'Styx' (RF) SS-21 'Scarab' (RF)	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-5 'Gammon' (RF) SA-6 'Gainful' (RF) SA-N-4 'Gecko' (RF)
Federal Republic of Yugoslavia (Serbia and Montenegro)	FROG-7 (RF) SS-N-2 'Styx' (RF) SS-N-3 'Shaddock' (RF) SA-2 variant (RF) RBS 15 (Sweden) K-15 Krajina	SA-2 'Guideline' (RF) SA-3 'Goa' (RF) SA-6 'Gainful' (RF) SA-8 'Gecko' (RF) SA-11 'Gadfly' (RF) SA-N-4 'Gecko' (RF)
(for Zaire please see Democratic Republic of Congo)		
Zambia		SA-3 'Goa' (RF) SA-6 'Gainful' (RF)

COUNTRY INVENTORIES – IN DEVELOPMENT

Country	Offensive Weapons	Defensive Weapons
Argentina		Halcon
Australia		Evolved Sea Sparrow (joint programme)
Brazil	TM-Astros	FOG-MPM
Canada		Evolved Sea Sparrow (joint programme)
People's Republic of China	CSS-NX-5 (FL-2) FL-10 (joint programme) JL-1A JL-2 DF-25 TV-guided ASM CSS-X-10 (DF-41) HN-2/-3 HN-2000 CF-2000 YJ-91 GWM-80 FF-1	KS-2 ASAT HQ-9 HQ-15 HQ-16 HQ-17
Denmark		Evolved Sea Sparrow (joint programme)
Egypt	Vector	
France	MSBS M-51 ANF (joint programme) ASMP-A TRIFOM (joint programme) Milas (joint programme) Apache SCALP-EG/Storm Shadow (joint programme) NSM (joint programme)	Aster 30 (joint programme) Latex Hypervelocity Gun (joint programme) TRIFOM (joint programme) VL-MICA
Germany	KEPD 150/350 Taurus (joint Programme) TRIFOM (joint programme) Triton	Ground-Based Laser (GBL) TLVS MEADS (joint programme) Hypervelocity Gun (joint programme) Evolved Sea Sparrow (joint programme) HFK TRIFOM (joint programme)
Greece		Evolved Sea Sparrow (joint programme)
India	Prithvi SS-350 Agni 2 plus/3 Dhanush Sagrika Koral Cruise Missile PJ-10 Brahmos (joint programme)	Akash 2 Trishul
Iran	Shahab 4/5 CSS-6 (M9) variant CSSC-2 'Silkworm' variant CSS-7 (M-11) variant Zelzal 3 Fateh 110 FL-10 (joint programme)	
Iraq	SRBM Ababil/Sakr Al Samoud IRBM L-29 Delfin conversion	FAW-1
Israel	Popeye 3 Jericho 3 Delilah CM Cruise Missile	ADAMS/Relampago/Defender Derby
Italy	Teseo 3 (Ulisee) Marte 2N/2S TRIFOM (joint programme)	Aster 15/30 (joint programme) MEADS (joint programme)
Japan	XSSM-2 ASM-3	TanSAM 2(Chu-SAM)
Korea, North	AG-1 (HY-2 variant) Taep'o-dong 1/2 SS-21 'Scarab' variant	
Korea, South	NHK-1A 'Hyon Mu' KSR-1 (KSR-420) ASM/SSM	
Libya	Iltisslat/Al Fatah 'Scud B' variant	
Netherlands		Evolved Sea Sparrow (joint programme)
Norway	NSM (joint programme)	Evolved Sea Sparrow (joint programme)
Pakistan	Hatf 2/3 Hatf 6 (Shaheen 2) Shaheen 3	Anza 3
Russian Federation	PJ-10 Brahmos (joint programme) SS-X-26 Kh-37 SS-NX-26 SS-NX-27 Kh-555 Kh-59ME Kh-38 Alfa Kh-65 SE Kh-41 Moskit (P-270) Kh-32 Kh-101/-102 Kh-SD SS-NX-30 Bulava	S-500 SA-NX-? Ground-Based Laser Airborne Laser Ship-Based Laser Future ASAT SA-19B Pantzyr-S1 MRADS ABM-4 R-77-3PK Vega SAM Sosna-R SA-3C (Pechora 2)
South Africa	IMUPSOW Raptor 1/2 Torgos	Kentron SAM SAHV-IRS/RS Umkhonto
Spain		Evolved Sea Sparrow (joint programme)
Sweden	KEPD150 Taurus (joint programme) RBS-15 Mark 3	BAMSE (RBS-23)
Syria	CSS-7 (M-11) variant CSS-6 (M-9) variant	
Taiwan	Sky Horse 1 (Tien Ma) Hsuing Feng 3	Sky Bow 3 Tien Chien 2
Turkey		Evolved Sea Sparrow (joint programme)
UK	Storm Shadow/Apache (joint programme)	PAAMS (Aster) (joint programme)
Ukraine		SAM
USA	GMLRS RGM-84E Sea SLAM AGM-158 JASSM ARRMD ALAM	Ground-Based Laser (THEL) Ship-Based Laser Airborne Laser (YAL-1) GMD Space Based Laser THAAD PAC-3(ERINT) Hypervelocity Guns EFOG-M (YMGM-157) MIM-120 NASAMS (joint programme) CKEM/LOSAT (MEADS) (joint programme) KE-ASAT Standard SM-3 (SMD) Evolved Sea Sparrow (RIM-162) (joint programme) MTHEL SWORD/MALI

OBSOLETE SYSTEMS

CSS-I (OF-2)

Type

Intermediate-range, surface-based, liquid propellant, single warhead ballistic missile.

Development

In the mid-1950s the Soviet Union supplied China with a number of SS-2 'Sibling' missiles, which were an adaptation of the German wartime V-2 short-range ballistic missile. Later some SS-2 missiles were locally produced under licence and designated DF-1 (*Dong Feng* = East Wind) by the Chinese. The first Chinese ballistic missile launch took place in November 1960 using a DF-1 fitted with a dummy payload. It now seems certain that the Chinese also had limited access to the somewhat larger SS-3 'Shyster' missile, a Soviet development of the SS-2. Following the break with Moscow in the early 1960s China used its existing production base to build its first indigenous missile, known in the West as the CSS-1 (Chinese Surface-to-Surface missile-l) and in China as Dong Feng 2. Some sources suggest that the CSS-1 was derived from the SS-3 airframe but used an upgraded SS-2 propulsion system (liquid oxygen and alcohol) known to have been manufactured in China. The date of the first CSS-1 (DF-2) launch is somewhat open, but is generally thought to have taken place in June 1964. After this flight the range was increased to 1,250 km, so as to be able to reach all US bases in Japan, with this second version known as DF-2A. A DF-2A missile was first flown in 1965. A CSS-1 (DF-2A) was used to launch a nuclear warhead into the Lop Nor atomic test area in October 1966. Even today, this is believed to be the only missile launch and detonation of a nuclear warhead by any nation. One of the main shortcomings of the CSS-1 as a weapon was the use of liquid oxygen as fuel, so the missile could not be stored fully fuelled for long periods or launched at short notice. Recognising this, in the early 1960s the Chinese started the development of a series of missiles using only storable propellants. These missiles went on to form the baseline design for the Chinese Long March satellite launch systems used throughout the 1980s and 1990s. and still in development today.

Description

The CSS-1 was a single-stage, transportable liquid fuelled missile, 20.6 m long and 1.65 m in diameter, with four delta fins at the base of the stage. The missile had a launch weight of 32,000 kg. Inertial guidance was assumed, with control by vanes in the efflux nozzles. The first operational warheads were believed to be smaller than those carried by the Soviet SS-3 'Shyster' missile. A figure of 15 kT has been suggested but a 20 kT warhead may have been fitted to some, and the warhead assembly weight was 1,500 kg. The original DF-2 design had a range of 1,050 km. but the improved DF-2A had a range of 1,250 km.

Operational status

Some 90 of these CSS-1 (DF-2A) missiles were deployed in northern China from 1966. Recent reports suggest that around 50 CSS-1 missiles were deployed in 1979 but that they were taken out of service in the 1980s. It is believed that a total of 100 missiles was originally built with production ending in 1969. At one stage it was thought that this missile would be deployed in large numbers or be replaced by solid-fuelled missiles. However, it now seems that the Chinese put the majority of their effort into the ICBM and SLBM programmes and these shorter range missiles have been removed from service.

A CSS-1 intermediate-range ballistic missile prepared for launch

Specifications

CSS-1 (DF-2A)
Length: 20.6 m
Body diameter: 1.65 m
Launch weight: 32,000 kg
Payload: Single warhead; 1,500 kg
Warheads: 15 kT or 20 kT nuclear
Guidance: Inertial
Propulsion: Single-stage liquid
Range: 1,250 km
Accuracy: n/k

Contractor

It is believed that DF-2 was designed by the First Academy of the Ministry of Aerospace Industry.

M-20

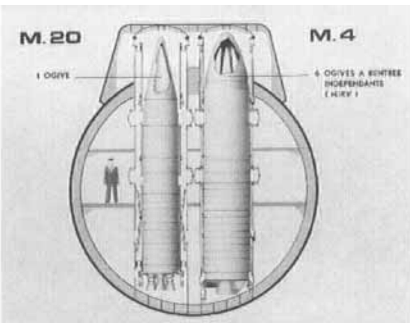
Type

Intermediate-range, submarine-launched, solid propellant, single warhead ballistic missile

Development

The M-20 was the third member of the MSBS (*Mer-Sol-Balistique-Stratégique*) family which comprised a number of submarine-launched, intermediate-range missiles, similar in form to the US Polaris and Poseidon families. The force constitutes the second leg of the French nuclear deterrent force.

The M-1 version went into service in 1971 and was phased out in favour of the M-2 in 1974, itself replaced by the M-20 in 1977. The new M-4 missile entered service in 1985 and has replaced the M-20. French nuclear-powered submarines (SNLE *Sous-marines Nucleaire Lanceur d'Engins balistique)* were able to carry 16 missiles each. The oldest boat, *Le Redoutable.* was not converted to carry the M-4 and was withdrawn from service in 1991.



***A** comparison drawing of the two systems. M-20 and M-4*

Description

The M-20 was a two-stage, solid propellant, intermediate-range ballistic missile, 10.40 m in length and 1.5 m in diameter. Launch weight was 20,000 kg and the missile had a range of 3,000 km. Control of the first stage was by four gimballed nozzles; the second stage by thrust vector control through a single fixed nozzle. The first stage propellant weighed 10,000 kg and burned for 55 seconds, the second stage propellantweighed 6.015 kg and burned for 58 seconds. Guidance was inertial. The payload was believed to include some penetration aids and the single re-entry vehicle had some hardening against nuclear effects. The TN-60 warhead was reported to have a yield of 1.2 MT.

Operational status

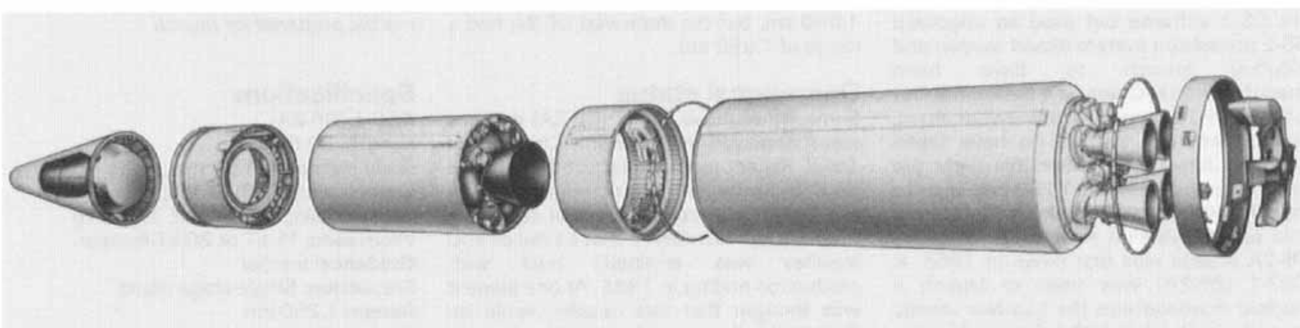
The M-20 system entered service in 1977. There were 100 missiles produced and the M-20 ceased operational deployment in 1991. There were no known exports.

Specifications

Length: 10.40 m
Body diameter: 1.5 m
Launch weight: 20,000 kg
Payload: Single warhead with penetration aids
Warhead: 1.2 MT nuclear
Guidance: Inertial
Propulsion: 2-stage solid
Range: 3,000 km
Accuracy: 1,000 m CEP

Contractor

Aerospatiale, Space and Strategic Systems Division, Les Mureaux (prime contractor).



***A** diagram of the main assemblies of the M-20 missile*

Pluton

Type
Short-range, road mobile, solid propellant, single warhead ballistic missile.

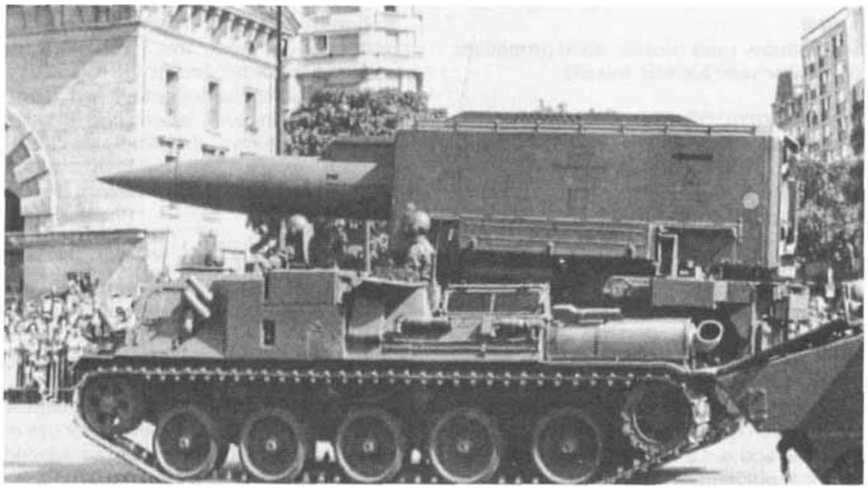
Development
Design of the Pluton nuclear capable SRBM started in the early 1960s and the system entered service in 1974 with the French Army. Plans for a Super Pluton were dropped in 1983 in favour of a new missile programme, called Hades.

Description
The Pluton missile was 7.64 m long and had a body diameter of 0.65 m. The missile had a launch weight of 2,423 kg and the single-stage solid propellant motor gave the missile a range of 120 km. Inertial guidance gave an estimated accuracy of 150 m CEP. The missile was believed to have conventional HE or nuclear warheads, with two nuclear warhead options at 15 or 25 kT yield, depending upon the target. The missile was carried on a modified AMX-30 tank chassis. Provision was made for real time targeting information to be passed to the Pluton command vehicle from a CT-20 drone.

Operational status
The Pluton system entered service in 1974 and it is believed that there were 30 launchers deployed with missiles, reloads and alternative warheads. The system was phased out of service in 1993. There were no known exports.

Specifications
Length: 7.64 m
Body diameter: 0.65 m
Launch weight: 2,423 kg
Payload: Single warhead
Warhead: HE or 15/25 kT nuclear
Guidance: Inertial
Propulsion: Single-stage solid propellant
Range: 120 km
Accuracy: 150 m CEP

Contractor
Aerospatiale, Space and Strategic Systems Division, Les Mureaux (prime contractor).



A Pluton missile being carried in its TEL vehicle

*Pluton missile being launched **from** its TEL vehicle, a converted AMX-30 tank chassis*

Hades

Type
Short-range, road mobile, solid-propellant, single warhead ballistic missile.

Development
The Hades Short-Range Ballistic Missile (SRBM) began project definition in 1975 as a replacement for the Pluton system. Development started in July 1984, and flight testing started in 1988. The Hades programme planned to build 120 missiles, some with nuclear and some with high explosive warheads. Originally designed with a range of 250 km, the range requirement was later increased to 480 km. Reports in 1993 stated that an additional version was being developed to attack buried hard targets, with GPS updates and a TV digital scene matching terminal guidance system, providing a CEP down to less than 5 m. However, the programme was terminated in 1993, after some 30 missiles had been built.

Description
Hades was designed for transportation on wheeled transporter-erector-launcher vehicles, with tractor and trailer, each trailer carrying two missiles in containers that also acted as launch boxes. The missile was reported to be 7.5 m long, with a body diameter of 0.53 m and a launch weight of about 1,850 kg. The missiles were capable of carrying either the nuclear TN-90 warhead with a yield of 80 kT, or conventional HE warheads.

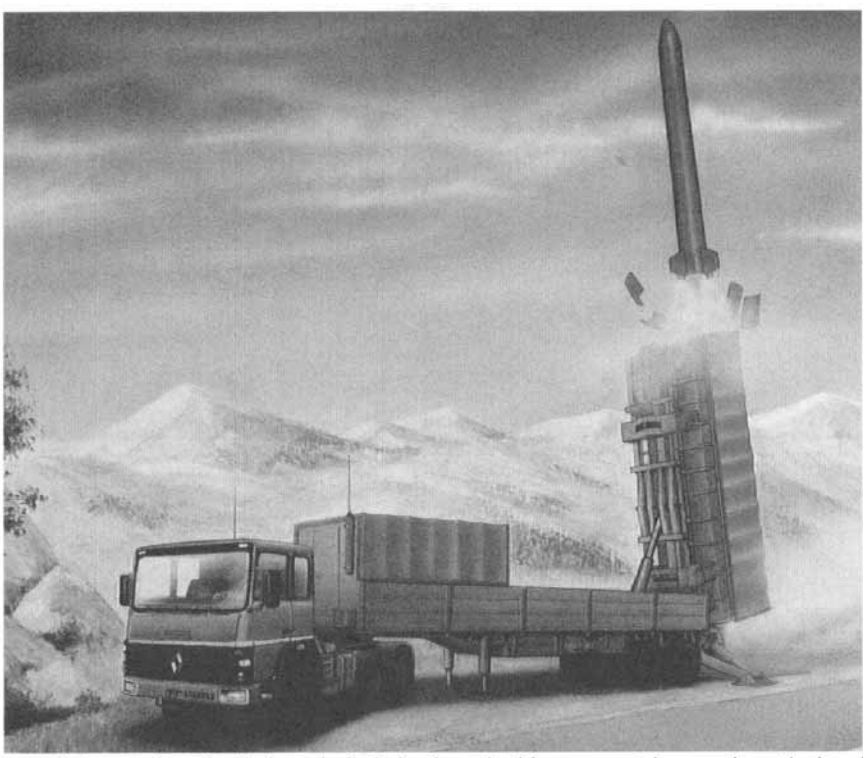
Reports suggest that the Hades trajectory was kept low, so that the aerodynamic control fins at the rear of the missile can alter the trajectory and range during flight, as well as making evasive manoeuvres during the terminal phase near the target. The minimum range was 100 km and the maximum range 480 km.

Operational status
The first flight test was made in 1988 and the Hades development was completed in 1992. The French government had decided in 1991 not to deploy the system operationally. and to limit production to 30 missiles and 15 TEL vehicles. The missiles and TEL were stored at Luneville, for use in an emergency. In 1996, it was announced that the warheads and missiles would be dismantled.

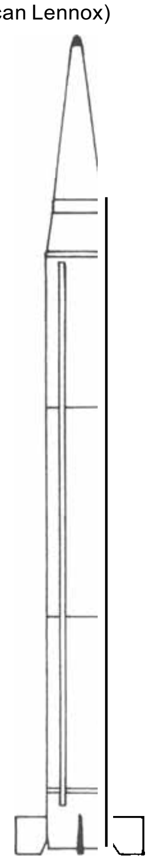
Specifications
Length: 7.5 m
Body diameter: 0.53 m
Launch weight: 1,850 kg
Payload: Single warhead
Warhead: HE or nuclear 80 kT
Guidance: Inertial
Propulsion: Single-stage solid propellant
Range: 480 km
Accuracy: n/k

Contractor
Aerospatiale, Les Mureaux (prime contractor).

A model. in the foreground. of the Hades missile displayed at the Paris Air Show in 7989 (Duncan Lennox)



Artist's impression of a Hades missile being launched from a container on the articulated trailer (Aerospatiale)



Outline diagram of Hades surface-to-surface missile

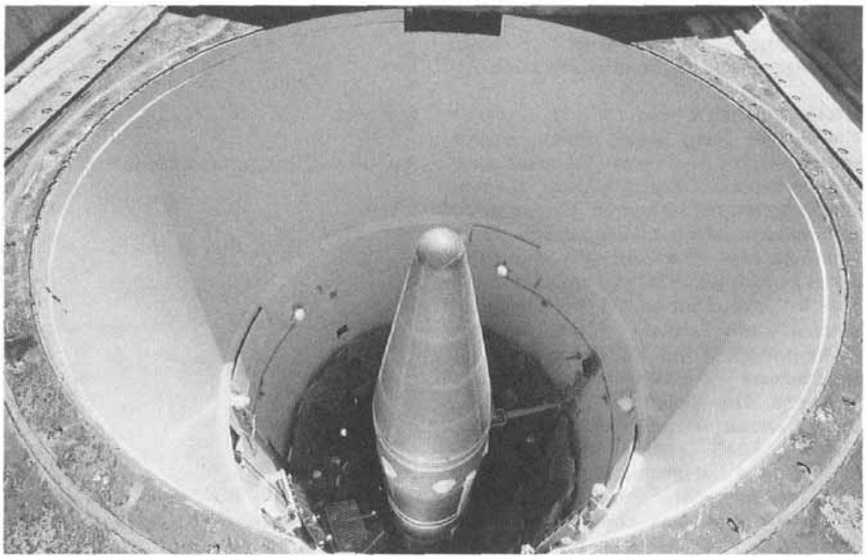
S-3

Type

Intermediate-range, silo-based, solid-propellant, single warhead ballistic missile.

Development

The French designation for the S-3 was the Type S-3D/TN-61. The original S-2 strategic missile force formed the main land-based element of the French *force de frappe*. (now the *force de dissuasion)* entering service in 1971. In 1973, a programme was initiated to develop the second-generation SSBS *(Sol-Sol-Balistique-Stratégique*) system, the S-3, entailing the renovation of the first two groups of S-2 silos and replacing the missiles with the S-3 model. Development of the S-3 was completed in 1980, and whilst it was initially planned that S-3 might be replaced by a land-based version of the M-5 missile by about 2005, plans announced in 1994 indicated that a land-based version of the M-45 missile might replace the S-3. However, in 1996, it was decided to deactivate the S-3 missiles, and that the S-3 would not be replaced.



A French S-3 intermediate-range ballistic missile in its silo (Aerospatiale)

Description

The S-3 was a two-stage, solid propellant, intermediate-range missile with a length of 13.8 m, a body diameter of 1.5 m and a launch weight of 25,800 kg. It had a range of around 3,500 km. S-3 had the same first stage as the S-2 with a solid-propellant P-16 motor with four gimballed nozzles, a weight of 16,940 kg and a 72 second burn time. A second stage, the P-6, originally developed for the MSBS *(Mer-Sol-Balistique-Stratégique*) M-20 missile, had a solid propellant weight of 6,015 kg and a burn time of 58 seconds. An advanced re-entry system was reported to be incorporated in the system. The re-entry system was also said to be radiation hardened and to contain a new system of penetration aids to improve defence penetration. The S-3 had a single nuclear warhead, TN6 1, believed to have a yield of 1.2 MT and carried within a payload of 1,000 kg.

Launch facilities included the silo, in which the missile was maintained in operational readiness, and an annex housing the automatic launching equipment and the support services. Launch facilities were hardened against nuclear effects

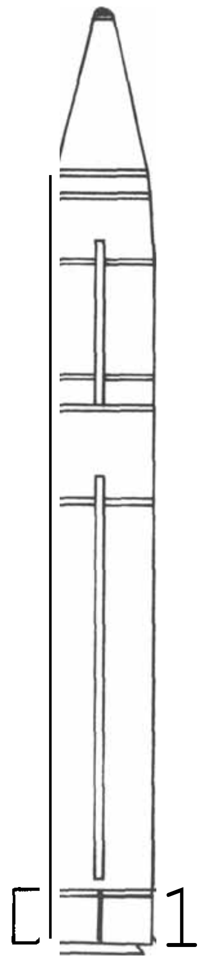
A French S-3 missile being test fired at the CEL (Landes Test Range)

Operational status

Deployment of the S-3 began in 1980. The first group of nine missiles and their associated silo installations on the Plateau d'Albion were officially inaugurated in May 1980; both groups of nine silos were operational by the end of 1982, making a total deployment of 18 missiles. Reports indicate that about 40 S-3 missiles were manufactured with a further 13 test missiles. The French government announced in 1996 that the S-3 missiles would be taken out of service and dismantled, and the 18 missiles were formally deactivated in September 1996.

Specifications

Length: 13.8 m
Body diameter: 1.5 m
Launch weight: 25,800 kg
Payload: Single warhead 1,000 kg
Warhead: 1.2 MT nuclear
Guidance: Inertial
Propulsion: 2-stage solid propellant
Range: 3,500 km
Accuracy: n/k



A line diagram of an S-3 ballistic missile

Contractor

Aerospatiale. Les Mureaux (prime contractor).

V-I Flying bomb (Fi 103)

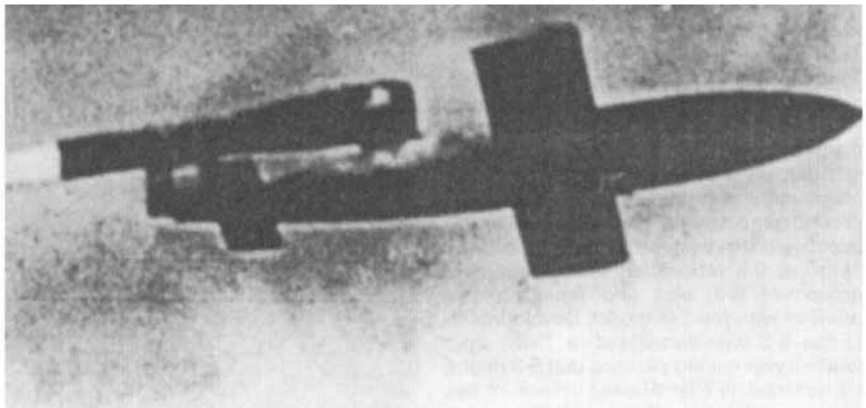
Type

Short-range, surface-based, pulse-jet propelled, single warhead cruise missile.

Development

The Fi 103 flying bomb, which became known as the V-1, was designed as a surface-to-surface cruise missile, but was later adapted for air-launch. This was the first cruise missile to be used in war. There had been trials of a form of guided flying bomb as early as 1930 and again in 1937. The V-1 programme did not begin in earnest until early 1942, when development of the V-2 ballistic missile experienced numerous technical problems. The design presented by Dr Robert Lussar of the Fieseler Works in March 1942 was accepted for development and production after only five days consideration. Production of the missile airframe was carried out at the Fieseler Works; Askania provided the guidance and control system, Argus Motor Works provided the power plant, and the Peenemunde test centre carried out the trials. The first models were tested by airdrops from a Focke-Wulf Fw 200C, and some modified versions, Type 2s, were actually test flown by pilots. The first successful ground launch took place in December 1942. In May 1943 there was a 'shoot-off' at Peenemunde between the V-1 and V-2, at which the two V-1s failed while the V-2s were successful; however, the decision was still made to produce both missiles. In 1943, Germany started construction of four large concrete bunkers as part of the 'Atlantic Wall', and a further 252 sites were selected. The first operational V-1 was fired against London on 12 June 1944, six days after the Allied invasion. As the coastal launch ramps were overrun, a long-range version of the V-1 (Fi 103i) was introduced to allow the attacks on the UK to continue from inland sites, and Allied ports in Europe were attacked; the German Air Force continued to launch V-1s from Heinkel III aircraft until the war ended. After the war a stock of some 200 piloted versions, known as Type 3s 'Reichenberg', were discovered. These had been developed for 'suicide flights' but were never put into operational use.

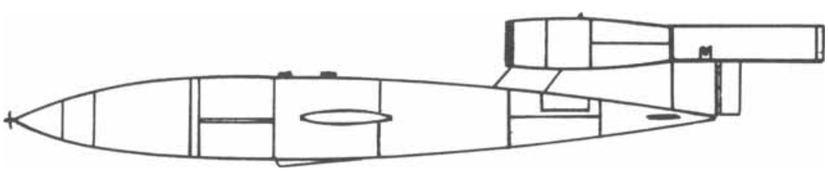
The USA copied the V-1 design, and this missile was called the Loon. The first flight was made in 1947, and later models were launched from the deck of a trials submarine as well as being dropped from B-29 bombers (known as Jet Bomb 2). The early trials models had a range of 85 km, but later versions flew for around 235 km.



The V-1 cruise missile during powered flight

Description

The V-1 cruise missile had the general configuration of a small aircraft with two rectangular wings at mid-body, a horizontal tailplane with elevator and a vertical tailplane with rudder. The rear-mounted, elevated pulse jet was supported at the front by a pylon and at the tail pipe by the vertical tail. The fuselage was aerodynamically shaped like that of a streamlined bomb and had a small propeller on its pointed nose to drive a distance counter. As well as the counter the nose section contained the guidance gyros, an 847 kg warhead with high explosive and an impact fuze. The central body and wing section contained the fuel tank and compressed air cylinder. The remainder of the fuselage carried the tail surfaces, power plant and contained the power plant regulator, flight controls and trailing antenna. The basic V-1 had an overall length of 7.74m, a maximum body diameter of 0.82m, a wing span of 4.9m and weighed 2,200kg at launch. The long-range version, which had a reduced payload of 450 kg, was 8.87m long and wooden wings with a span of 5.7m. Guidance was by autopilot with two gyros, and range was determined by the propeller-driven distance counter (odometer). As the V-1 was unstable at low speed, below 300 m/s, it was catapulted from an inclined set of rails about 35 m long. It then flew at about 560 km/h (350 mph) at an altitude of 760 m. On reaching the target area, at a distance determined by the odometer, the motor was stopped, the elevator kicked down and the wings jettisoned. Then, under the weight of the warhead the V-1 tipped over into a terminal dive and exploded on contact. The maximum range of the combat model was 285 km and of the long-range model was 370 km.



A line diagram of the V-1 (Fi 103)

Operational status

The V-1 was successfully tested in 1942 and entered operational service in 1944. Between 12 June 1944 and 5 September 1944, over 9,000 V-1s were launched of which 2,340 landed in the Greater London area killing more than 5,000 people. From June 1944 to June 1945 around 21,000 V-1 cruise missiles were launched at land targets in Europe. After the war, the US carried out many tests on captured V-1s, and also developed and tested American-built copies known as Loon and Jet Bomb 2.

Specifications

Fi 103
Length: 7.74m
Body diameter: 0.82m
Launch weight: 2,200kg
Payload: Single warhead; 847 kg
Warhead: HE
Guidance: Inertial
Propulsion: Pulse jet
Range: 285 km
Accuracy: n/k

Fi 103i
Length: 8.87m
Body diameter: 0.82m
Launch weight: n/k
Payload: Single warhead; 450 kg
Warhead: HE
Guidance: Inertial
Propulsion: Pulse jet
Range: 370 km
Accuracy: n/k

Contractor

The V-1 was designed and produced by the Fieseler Works, Germany.

V-2 (A-4)

Type

Short-range, surface-based, liquid propellant, single warhead ballistic missile.

Development

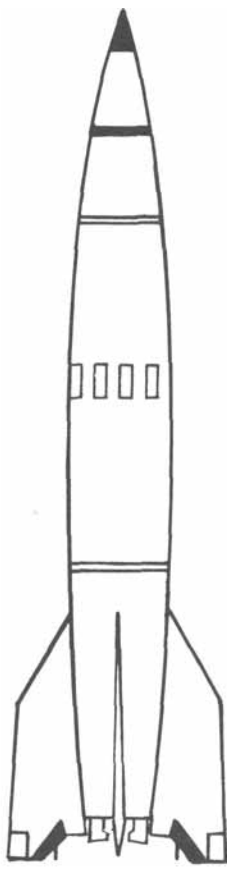
In the early 1930s the Germans began development of two 'V, for Vengeance, weapons: the V-1, a cruise missile, and the V-2 ballistic missile. The development of the V-2 ballistic missile was an Army programme under the direction of Captain Walter Dornier and Wernher von Braun. The first rocket, Aggregate 1 (A-I), which blew up when tested in 1932, was built for static tests only. In 1934 two A-2 rockets were successfully test flown and climbed to altitudes of about 2,400 m. The A-3 was purely a research vehicle incorporating for the first time stabilising fins as well as exhaust jet deflectors, and a recovery parachute. This was tested several times between 1935 and 1937. The major project was to be a large artillery rocket (ballistic missile) designated A-4. Parts of the design were tested on a small scale rocket designated A-5. The first A-5 was launched in mid-1938, without a guidance system, and reached a height of 12,800 m. The A-5 remained the standard test vehicle until 1942, when the first successful launch of an A-4 (now the V-2) took place at the German Army Test Centre at Peenemunde. In May 1943 there was a 'shoot-off' at Peenemunde between the V-1 and V-2, at which the two V-1s failed while the V-2s were successful; however, the decision was made to proceed with both projects. After this, mobile V-2 batteries were organised and deployed to coastal sites. The first V-2 attack on the UK was launched on 8 September 1944 from a site near The Hague in The Netherlands. Between then and 27 March 1945 (last launch of a V-2 against the Allies) firings were also made against targets in northern France and Belgium.

Description

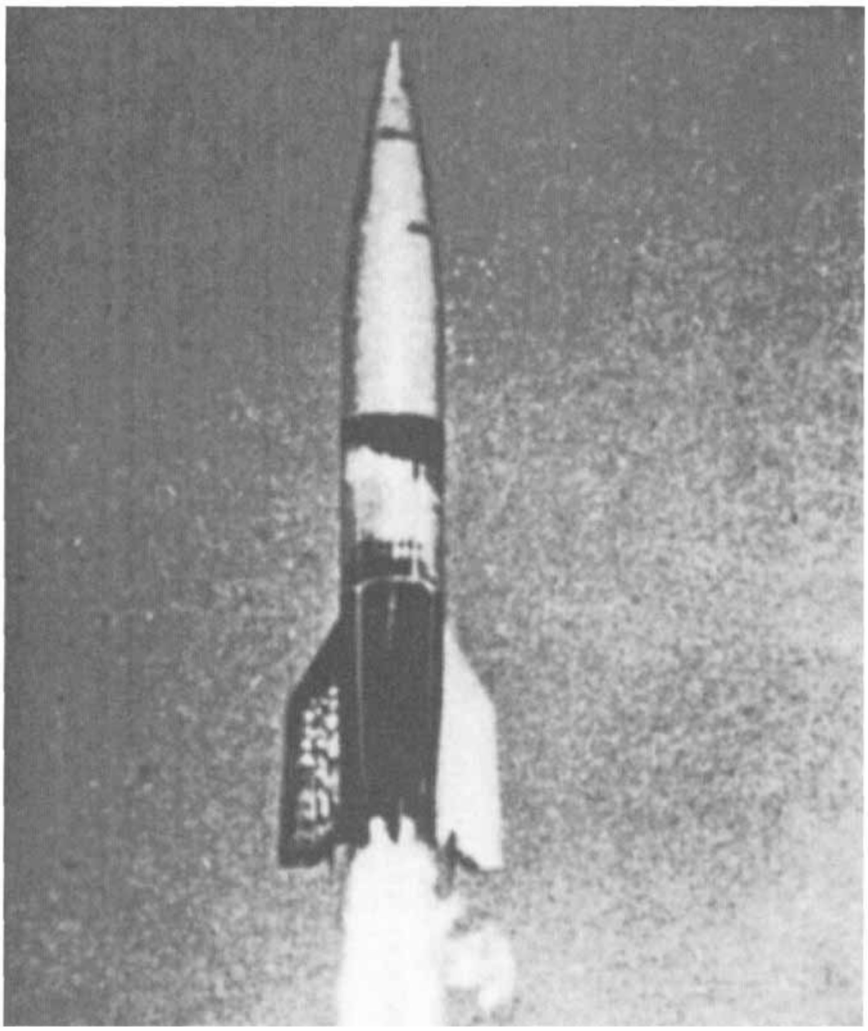
The V-2 was a single-stage, liquid-propelled ballistic missile, which had the general appearance of a large streamlined bomb with a pointed nose and four large clipped delta stabilising fins at its base. The nose section of the missile contained a 1,000 kg warhead with 750 kg high-explosive and an impact fuze. Behind this was the radio set (FUMG) and autopilot guidance system. The central body section contained the methyl alcohol and liquid oxygen tanks in tandem, and the rear section the motor assembly electric power generator, and control hydraulics. In the tip of each stabilising fin were small electrically operated, rectangular aerodynamic rudders, which were mechanically coupled to four jet exhaust deflectors. The radio antennae formed part of the fin trailing-edges. The V-2 was 14.00 m long, had a maximum body diameter of 1.65 m, a finspan of 3.56 m. and weighed 12,900 kg at launch. Guidance was by radio-command assisted by a three-axis gyro-control system working the exhaust deflectors and fin tip rudders. The radio commands were only used to monitor the boost phase trajectory, and to close down the motor when the correct velocity has been reached. The V-2 was designed to be road and rail mobile, and could be erected, fuelled, checked out and vertically launched from any hard surface in about 1 hour. It reached an apogee of about 85 km, had a maximum velocity of 1.6 km/s and a maximum range of 350 km with a Circular Error of Probability (CEP) of 15 to 20 km.

Operational status

The V-2 was successfully tested in 1942 and entered operational service in 1944. Between September 1944 and March 1945. some 4.300 were launched at a rate of around 20 per day. Of these 1,359 were launched against London, of which 1,054 (78 per cent) actually struck somewhere in England, and of those 517 landed inside the 1,890 km^2 area of Greater London killing 2,480 people. The US Army



A line diagram of the V-2 missile



The successful test launch of a V-2 (A-4) ballistic missile

captured the V-2 manufacturing plant at Nordhausen in April 1945, and one month later Wernher von Braun surrendered to the US Army after fleeing west from Peenemünde.

The US Army took over 100 complete missiles back to the USA for testing at the White Sands Missile Range, where they provided invaluable data for the beginning of America's missile programme. In February 1949 the **US** used a V-2 as the boost stage for the Bumper WAC rocket, which **was** the first vehicle to penetrate space. The UK rebuilt eight V-2s and tested three successfully in late 1945. On 4 May 1945 the Russians captured and took control of Peenemunde and many of its scientists and engineers. In 1950 they produced their first ballistic missile the SS-1A 'Scunner'. which was also a direct derivative of the V-2.

Specifications

Length: 14.00 m
Body diameter: 1.65 m
Launch weight: 12,900 kg
Payload: Single warhead; 1,000 kg
Warhead: 750 kg HE
Guidance: Command and inertial
Propulsion: Liquid propellant
Range: 350 km
Accuracy: 15,000 to 20,000 m CEP

Contractor

The V-2 was designed at the German Army Test Centre at Peenemunde (HVP).

Al Abbas

Type

Intermediate-range, road mobile, liquid propellant, single warhead ballistic missile.

Development

The Al Abbas, also known as al-Abos or El-Abbas, was the second intermediate-range ballistic missile (IRBM) claimed to have been designed and developed in Iraq. It is believed that this missile was also a modified 'Scud B', with a smaller warhead and further increased capacity liquid-propellant tanks from the Al Hussein design. Al Abbas has its first test flight in April 1988 and was reported to have had a range of 900 km. Subsequent reports indicate that development of the missile was stopped around 1990, perhaps due to the instability of the weapon and poor overall performance of the system. It is believed that work proceeded on an alternative design, upgrading the propellants and motor design of the Al Hussein, in order to achieve a greater range and payload.

Description

Al Abbas was an intermediate-range, road mobile, liquid-propelled single warhead ballistic missile. It was reported to be 13.75 m long, with a body diameter of 0.88 m, and a launch weight of 7,870 kg. A payload of around 225 kg. significantly reduced from the 'Scud B' payload of 985 kg, probably included a single conventional blast/HE fragmentation or chemical warhead. Al Abbas was believed to have had inertial guidance, and at a range of 900 km an accuracy of no better than 3 km. The guidance system controlled the movement of vane type jet deflectors positioned in the liquid propellant motor exhaust. These adjusted the flight path of the missile during the climb after launch. Al Abbas was designed to be carried and launched from the same eight-wheeled Al-Waleed Transporter Erector Launcher (TEL) used for the Al Hussein missile, and was probably also carried by a modified Russian MAZ 543 TEL (as used for the SS-1 'Scud B').

Operational status

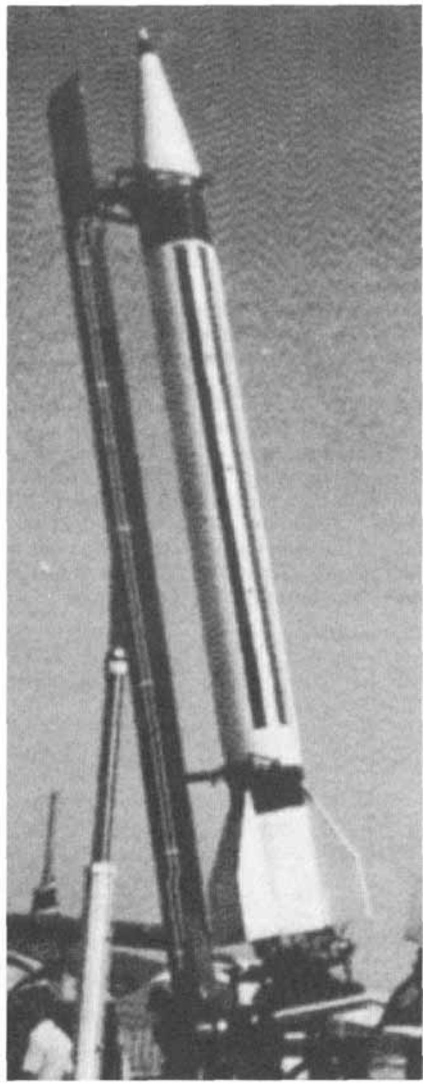
Although the first test flight of Al Abbas was reported *to* have taken place in 1988, it would appear that none were fired in the 1991 Gulf War. This would seem to confirm that the development programme was stopped around 1990 and the missile did not go into production.

Specifications

Length: 13.75 m
Body diameter: 0.88 m
Launch weight: 7,870 kg
Payload: 225 kg (single warhead)
Warhead: Conventional HE or chemical
Guidance: Inertial
Propulsion: Liquid propellant
Range: 900 km
Accuracy: 3,000 m CEP

Contractor

Not known.



An Al Abbas IRBM on a mobile launcher

Al Aabed

Type

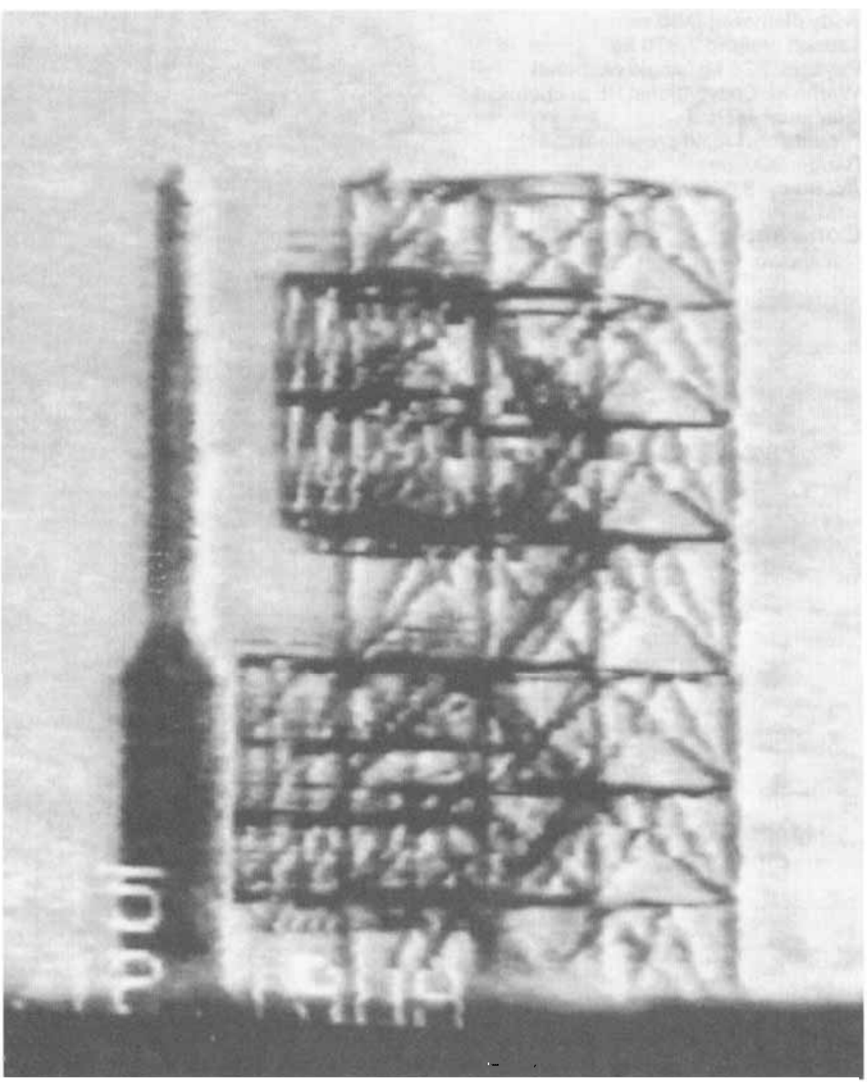
Intermediate-range, ground-launched, liquid propellant, single warhead ballistic missile.

Development

The announcement by the Iraqi government of the successful launch of the Tamouz 1 satellite launch vehicle on 5 December 1989, together with the statement that there had been two tests earlier in 1989 of a new intermediate-range ballistic missile called 'Al Aabed' or 'Al Abid' (The Worshipper), gave the impression that the two programmes were linked. If this was the case, then certain parameters for the Al Aabed missile could be deduced from the Tamouz launcher. The Tamouz launcher was reported to be 24.4 m long, weigh 48,000 kg and to have a launch thrust from the first stage of 70 tonnes. From the video released of the launch it would appear that the Tamouz 1 first stage was made up from five Al Abbas type liquid fuelled motor sections in a cluster. The Al Abbas being the larger of the two SS-1 'Scud' missile variants developed by the Iraqis, with a total launch weight of around 8,000 kg. The second stage appeared to be another Al Abbas motor section with a shorter 3.5 m third stage on top. Later reports suggested that the Tamouz SLV was a different design to the Al Aabed ballistic missile, but this has not been confirmed.

Description

If it is correct that the Al Aabed missile was similar to the Tamouz 1 launcher then the missile was probably about 23.0 m long, with a launch weight of 48,000 kg. The missile had three liquid fuelled stages, the first was a cluster of five Al Abbas type motor sections, the second stage was a single Al Abbas motor section and the third stage had a payload of about 750 kg, sufficient to contain a single HE or chemical warhead. The missile had inertial guidance and the Iraqis claimed that it had a range of 2,000 km.



This photograph was taken from the video of the launch of the Tamouz 1 satellite launch vehicle at Al Anbar Space Research Centre on 5 December 7989

Operational status

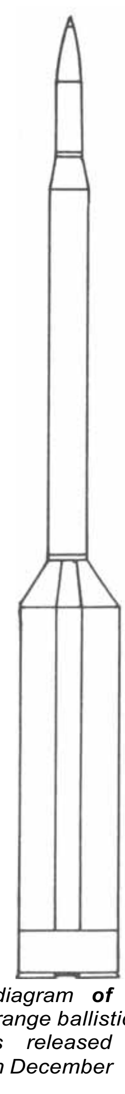
Following the two test launches reported by Iraq in 1989, and with consideration for the fact that the Al Aabed missile uses well proven liquid fuel technology, it would seem reasonable to have expected that such a missile could enter service. However, following the 1990-91 Gulf War, the continued development of Al Aabed seems doubtful and the programme is assumed to have been terminated by UN destruction of the manufacturing facilities.

Specifications

Length: 23.0 m
Body diameter: 1st stage 2.3 m; 2nd stage 0.9 m
Launch weight: 48,000 kg
Payload: Single warhead; 750 kg
Warhead: HE or chemical
Guidance: Inertial
Propulsion: 3-stage liquid
Range: 2,000 km
Accuracy: n/k

Contractor

Not known.



An outline diagram of the Al Aabed intermediate-range ballistic missile, based upon details released by the Iraqi government in December 1989

SS-1A 'Scunner' (R-1/8 Zh 38/8A11)

Type
Short-range, surface-based, liquid propellant, single warhead, ballistic missile.

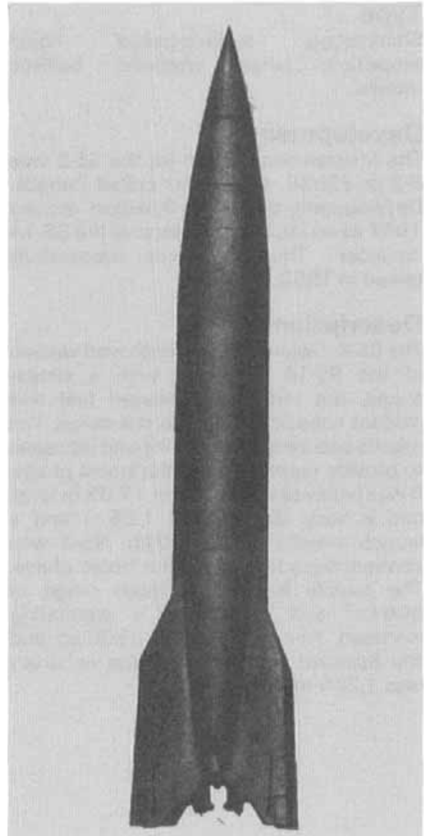
Development
The Russian designation for the SS-1A missile was R-1 (R for raketa, 'rocket') and is also believed to have had the designators 8 Zh 38 and 8A11. Development of the SS-1A began in 1945, when a decision was taken by the Russians to build versions of the German A-4 (V-2), largely directed and funded by the military. It appears that two groups worked on creating derivatives of the V-2: one drawn from Germans who had not fled to the West, the other a Russian group under SP Korolyev. Both teams' missiles were successfully tested in 1948 and the Korolyev design was selected as the R-1. The R-1 missile was reported to have performed better than the 300 km range German-designed V-2. The Russian Navy pursued its own versions of the V-2, called Golem 1 and 2, but neither was ever deployed. Modified R-1 missiles were used for space-launch vehicles.

Description
The SS-1A 'Scunner' was a derivative of the German V-2 ballistic missile, with a single stage, liquid propellant motor. The SS-1A is believed to have been 14.65 m long, with a body diameter of 1.65 m and a launch weight of 13,400 kg. The fin span was 3.56 m, with four clipped-tip delta fins at the base of the missile body. The missile was command guided. R-1 had a range of 270 km. The payload was 1,075 kg, and is believed to have included a 750 kg high explosive warhead. The payload remained attached to the propellant tanks and motor. The accuracy was reported by the Russians to have been 1,500 m CEP.

Operational status
The SS-1A (R-1) was introduced into service in 1950, although it is not clear on what scale. It was replaced two to three years later by the SS-2 'Sibling' and SS-3 'Shyster'.

Specifications
Length: 14.65 m
Body diameter: 1.65 m
Launch weight: 13,400 kg
Payload: Single warhead 1,075 kg
Warhead: HE
Guidance: Command
Propulsion: Liquid propellant
Range: 270 km
Accuracy: 1,500 m CEP

Contractor
SS-1A was designed by the Korolyev Design Bureau (now NPO Energia).



A model of SS-1A 'Scunner' (R-1), the Russian version of the German V-2 missile

SS-2 'Sibling' (R-2/8Zh38)

Type
Short-range, surface-based, liquid propellant, single warhead, ballistic missile.

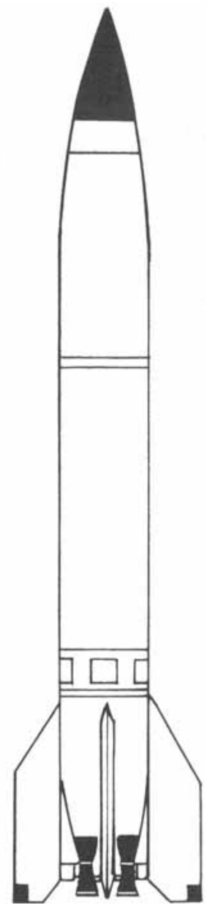
Development
The Russian designation for the SS-2 was R-2 or 8Zh38, and it was called Pobeda. Development of the SS-2 began around 1947 as an improved version of the SS-1A 'Scunner'. The SS-2 was successfully tested in 1950.

Description
The SS-2 'Sibling' was an improved version of the SS-1A 'Scunner' with a similar shape, but with an increased fuel and oxidant capacity to double the range. The missile had aerodynamic fins and jet vanes to provide control during the boost phase. It was believed to have been 17.65 m long, had a body diameter of 1.65 m and a launch weight of 20,400 kg. SS-2 was command-guided during the boost phase. The missile had a maximum range of 600 km and introduced a separating warhead. The payload was 1,500 kg, and the Russians reported that the accuracy was 1,250 m CEP.

Operational status
The SS-2 entered service in 1952, although it is not clear how many were deployed operationally. It was later replaced by the SS-3 'Shyster'.

Specifications
Length: 17.65 m
Body diameter: 1.65 m
Launch weight: 20,400 kg
Payload: Single warhead 1,500 kg
Warhead: HE
Guidance: Command
Propulsion: Liquid propellant
Range: 600 km
Accuracy: 1,250 m CEP

Contractor
It is believed that the SS-2 was designed by the Korolyev Design Bureau (now NPO Energia).



*A line diagram **of the SS-2** Sibling' missile*
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SS-3 'Shyster' (R-5/-5M and 8A62/8K51

Type

Intermediate-range, surface-based, liquid propellant, single warhead ballistic missile.

Development

The Russian designation for the SS-3 was R-5 and 8A62. Development of the SS-3 began in 1950, and was the third version of a ballistic missile system based on the German V-2. The SS-3 was first tested in 1952, but was not displayed in public until 1957. An upgraded version, R-5M or 8K5 1, was tested in 1956 and was the first Russian nuclear armed ballistic missile. The SS-3 was used as the basis for the design of a space launch vehicle known as V-5, but this was never built. It is believed that the SS-3 designs were passed to China around 1958.

Description

The SS-3 'Shyster' was an improved version of the SS-1A and SS-2 missiles. It was 20.8 m long and had a body diameter of 1.65 m. The launch weight was 28,000 kg, and the single-stage liquid propellant motor gave the missile a maximum range of 1,200 km. The payload assembly weighed 1,500 kg and contained an HE warhead. The payload separated from the missile body in flight. The range put the missile in the formally known 'medium' range, that is, at the lower end of the intermediate range. Guidance was by command, operating on vanes in the efflux nozzles during the boost phase. It may be that an early range maximum of 800 km was increased because of a change in fuel used in the SS-3. Originally, the missile was fuelled with liquid oxygen and alcohol, but later the alcohol was changed to kerosene and the range increased to 1,200 km.

The improved R-5M version had an increased launch weight of 29,500 kg. The payload was 1,350 kg, and was fitted with a nuclear warhead with a yield of 30 kT. The maximum range was 1,200 km and the accuracy 2,000 m CEP.

Operational status

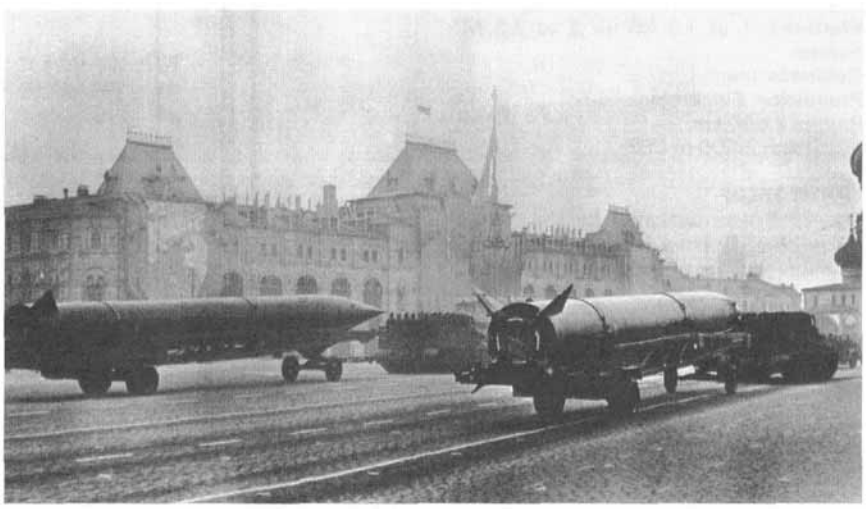
The SS-3 (R-5) entered service in 1953, but was not widely deployed with only 28 missiles in service. The improved nuclear version, R-5M entered service in 1956. The SS-3 missiles were replaced by the SS-4 'Sandel' and the SS-12 'Scaleboard'.

Specifications

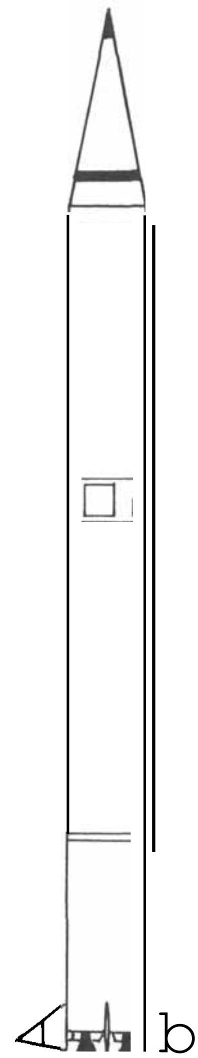
Length: 20.8 m
Body diameter: 1.65 m
Launch weight: 28,000 kg (R-5). 29,500 kg (R-5M)
Payload: Single warhead 1,500 kg (R-5). 1,350 kg (R-5M)
Warhead: HE (R-5) or 30 kT nuclear (R-5M)
Guidance: Command
Propulsion: Liquid propellant
Range: 1,200 km
Accuracy: 2,000 m CEP (R-5M)

Contractor

It is believed that the SS-3 was designed by the Korolyev Design Bureau (now **NPO** Energia).



Two SS-3 'Shyster' (R-5) missiles displayed in Moscow in 1957 (John W R Taylor)



*A line diagram **of** the **SS-3** 'Shyster' ballistic missile* 0044934

SS-4 'Sandel' (R-12/8K63)

Type

Intermediate-range, surface-based, liquid propellant, single warhead ballistic missile.

Development

The Russian designation for the SS-4 missile was R-12 (8K63). Development of the SS-4 began in 1948 and was essentially an evolution of the SS-3 'Shyster'. Testing began in 1955 and the missile was deployed in 1959. The SS-4 was essentially the standard Russian intermediate range missile in the inventory up to the introduction of the SS-20. The initial version (R-12) was ground launched, whilst a second version (R-12U/ 8K63U) was silo-based using the Dvina launch complex. The SS-4 missile was used as the basis for the SL-7 space launch vehicle.

Description

The SS-4 was an early generation, liquid propellant, single stage ballistic missile, 18.4 m long and 1.65 m in diameter. It had a launch weight of 41,700 kg and a maximum range of 2,000 km. SS-4 had a single re-entry vehicle with a weight of 1,630 kg, that separated from the motor assembly after motor burn-out using a pneumatic release system. The nuclear warhead could be either 1 to 1.3 MT yield or 2 to 2.3 MT yield. The accuracy is reported to have been 2,400 m CEP. The ground-launched missile was really fixed-based, as the complete weapon system of 12 tractor vehicles required 20 men to erect and to prepare for launch.

The missile used kerosene fuel and nitric acid as the oxidiser, with the oxidiser tank at the front of the missile and the fuel at the rear. The SS-4 used a RD-214 motor, with four combustion chambers and used a starting fuel for ignition. A single turbopump was driven by a hydrogen peroxide gas generator. The RD 214 motor developed 635 kN of thrust at sea level, with a total burn time of 140 seconds and a weight of 645 kg. The guidance system was originally radio command, operating on vanes in the efflux nozzles, but by 1962, the changeover to inertial guidance had been completed. Control was by four moving vanes in line with the four combustion chamber nozzles.

The silo-based version, R-12U, had a launch weight of 42,200 kg, but otherwise was similar to the earlier R-12.

Operational status

The R-12 missile was deployed from 1959 until 1987, and the silo-based R-12U was deployed from 1964 to 1987. The missiles were gradually replaced from 1977 by the SS-20 'Saber'. The missile was first displayed in 1961, and rose to public attention at the time of the Cuban missile crisis, in 1962. Reports suggested that the SS-4 had a reload capacity when fired from soft sites, using a fixed ground launcher.

At the time of the initialing of the INF Treaty in December 1987, Russia declared 65 deployed SS-4 missiles, with a further 105 missiles not deployed. Under the terms of the treaty, all of the SS-4 'Sandel' missiles were withdrawn and destroyed by May 1991.

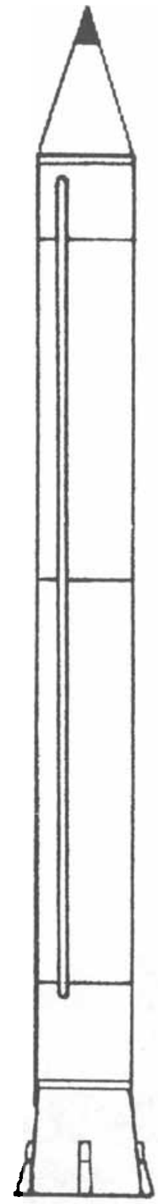
An unconfirmed Israeli report in 1997 suggested that SS-4 technologies had been provided to Iran, but this was denied by the Russian Federation.

Specifications

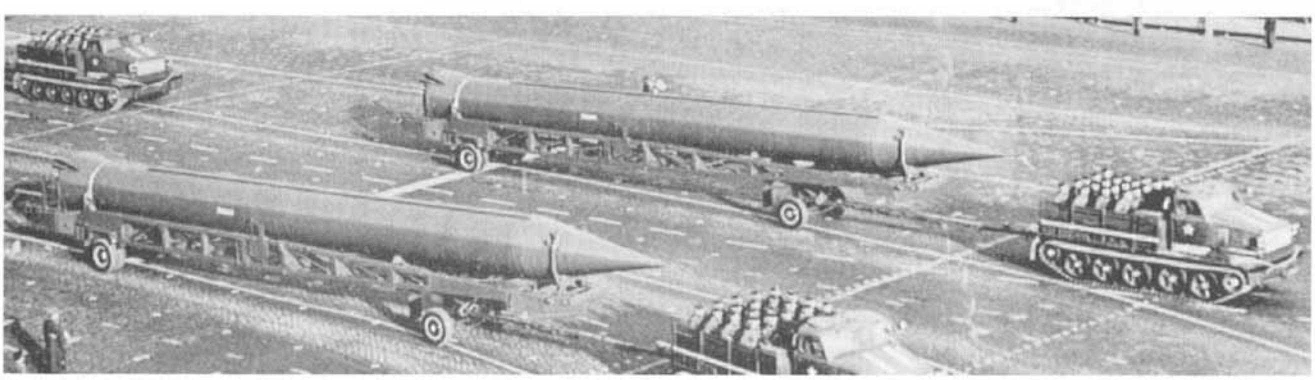
Length: 18.4 m
Body diameter: 1.65 m
Launch weight: 41,700 kg (R-12). 42,200 kg (R-12U)
Payload: Single warhead, 1,630 kg
Warhead: 1 to 1.3 MT or 2 to 2.3 MT nuclear
Guidance: Inertial
Propulsion: Single stage liquid
Range: 2,000 km
Accuracy: 2,400 m CEP

Contractor

The SS-4 was designed by the Yangel Design Bureau (now NPO Yuzhnoye) and manufactured by ASA Polyot.



A line diagram of the SS-4 Sandel' ballistic missile
0044935



SS-4 'Sandel' missiles on parade in Moscow in 7965

SS-5 'Skean' (R-14/8K65)

Type
Intermediate-range, surface-based, liquid propellant, single warhead ballistic missile.

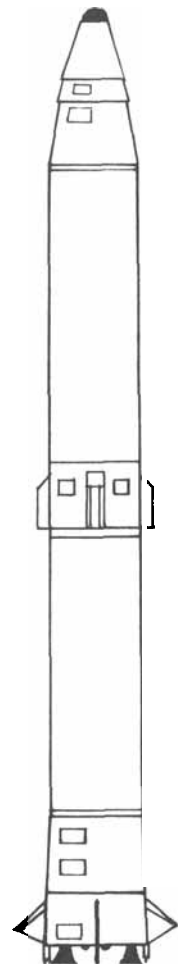
Development
The Russian designation for the SS-5 missile was R-14 and 8K65. It was first seen on display in a Moscow parade in November 1964 and was a further development of the SS-3 'Shyster'/SS-4 'Sandel' series of liquid propelled IRBMs. Development of the SS-5 is believed to have begun in the late 1950s and the missile was first deployed in 1961. An improved version, R-14U, with the designator 8K65U, was introduced in 1964. A development of the SS-5 (R-14U) was used to form the SL-8 Kosmos space launch vehicle.

Description
The SS-5 'Skean', although similar in configuration to its predecessors the SS-3 and SS-4 missiles, could be identified by its blunted nose. The SS-5 was 20.6 m long, had a body diameter of 2.4 m and a launch weight of 87,000 kg. The single-stage liquid propellant motor system used unsymmetrical dimethylhydrazine with nitric acid, which was self-igniting. There were two motors side by side, each with two combustion chambers and turbopumps. Control was by four gimballed liquid propellant control motors. The missile had a maximum range of 4,500 km. Guidance was inertial. The payload could be varied between 1,300 and 2,155 kg, although the heavier payload would have reduced the range. The SS-5 had a single separating 1 MT or 2 to 2.3 MT nuclear warhead, and an accuracy of 1,900 m CEP. There were unconfirmed reports that later versions (the Mod 3 or R-14U) had two MRV's each with a 300 kT warhead and an estimated CEP of 1,000 m, although Russian reports state that there were only single warhead versions. The SS-5 'Skean' was carried on a different trailer to its predecessors, towed by a 4 x 4 wheeled heavy tractor vehicle. Some SS-5 missiles were placed in Chusovaya underground launch silos, but only about half were ever deployed in this way. The earlier missiles were deployed in above ground soft launch sites.

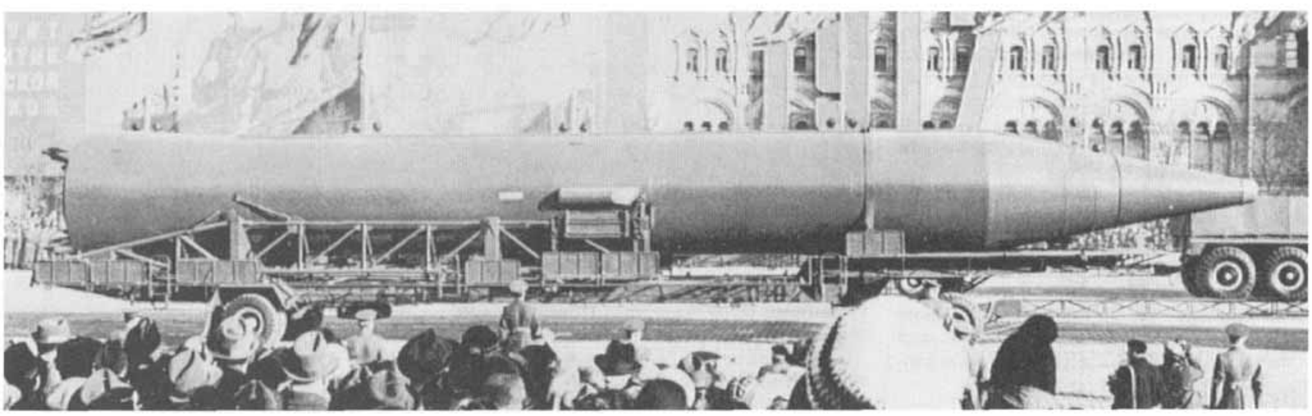
Operational status
The SS-5 entered operational service in 1961 and at their peak in the mid-1960s. almost 100 were deployed, mostly targeted on western Europe. The upgraded R-14U missiles were deployed in 1964. All were retired by 1984, having been replaced by SS-17 and SS-19 missiles.

Specifications
Length: 20.6 m
Body diameter: 2.4 m
Launch weight: 87,000 kg
Payload: Single warhead 1,300 to 2,155 kg
Warhead: 1 MT or 2 to 2.3 MT nuclear
Guidance: Inertial
Propulsion: Single-stage liquid propellant
Range: 4,500 km
Accuracy: 1,900 m CEP

Contractor
SS-5 was designed by the Yangel OKB (now NPO Yuzhnoye).



A line diagram of the SS-5 'Skean' ballistic missile
0044936



The SS-5 liquid propelled IRBM on display in the Moscow parade November 1964

SS-6 'Sapwood' (R-7/8K7 1/8K74)

Type

Intercontinental-range, surface-based, liquid propellant, single warhead ballistic missile.

Development

The Russian designation for the SS-6 missile was R-7 (also 8K7 1 and 8K74) and it was known as Semyorka (the Old Seven). Designed by the Korolyev design bureau, it was the world's first intercontinental ballistic missile. Development is thought to have started in the early 1950s. The first test flight took place on 3 August 1957 and the missile became operational in 1960. The highly unstable, non-storable liquid propellant severely limited the reliability and effectiveness of the SS-6, and only a small number of missiles ever became operational. Though the SS-6 did not materialise as a viable weapon system, SS-6 technology was later used as a booster for over 1,300 satellite launches, including the launch of the first three Sputnik satellites, being the basis of the **SL-1** (Sputnik), SL-2, SL-3 (Vostok), SL-4 (Soyuz), SL-5 and **SL-6** (Molniya) space launch vehicle series.

Description

The SS-6 'Sapwood' (R-7/8K7 1) missile was 27.0 m long, had a body diameter of 2.95 m and a launch weight of 276,000 kg. A single-stage liquid propellant system, with four strap-on liquid propellant boosters, carried a 5,400 kg payload to a maximum range of 8,000 km. Guidance was inertial, but with radio commands during the early boost motor phase. The accuracy was 3,000 m CEP. The SS-6 missile shape was unusual as four liquid strap-on boosters were arranged in a conical shape around the first stage, each tank having four combustion chambers and using liquid oxygen and kerosene. The overall base diameter was over 10 m. The missile had a separating single 5 MT yield nuclear warhead.

A second version, R-7A/8K74, had a launch weight of 276,000 kg and a payload of 3,700 kg. The lighter payload increased the range to 9,500 km, and the warhead had a yield of 3 MT.

Operational status

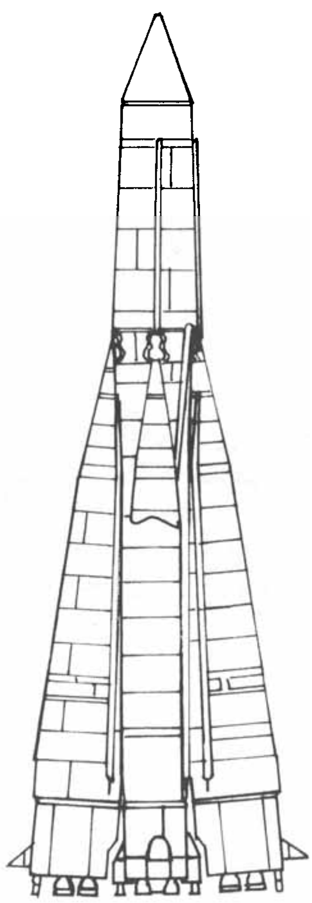
The SS-6 'Sapwood' first test flight was in May 1957 and the missile entered operational service in 1960. The R-7A version entered service in 1961. SS-6 could not be launchedfrom silos and tooka day to fuel before launch. It is believed that around ten missiles entered service, and that they were removed from service between 1964 and 1968, being replaced by SS-7 and SS-8 missiles. The SL-1 (Sputnik) launchers used the core stage of SS-6 'Sapwood', with the first successful launch on 4 October 1957. Later satellite launch vehicles (SL-4, SL-6) used three and four stages.

Specifications

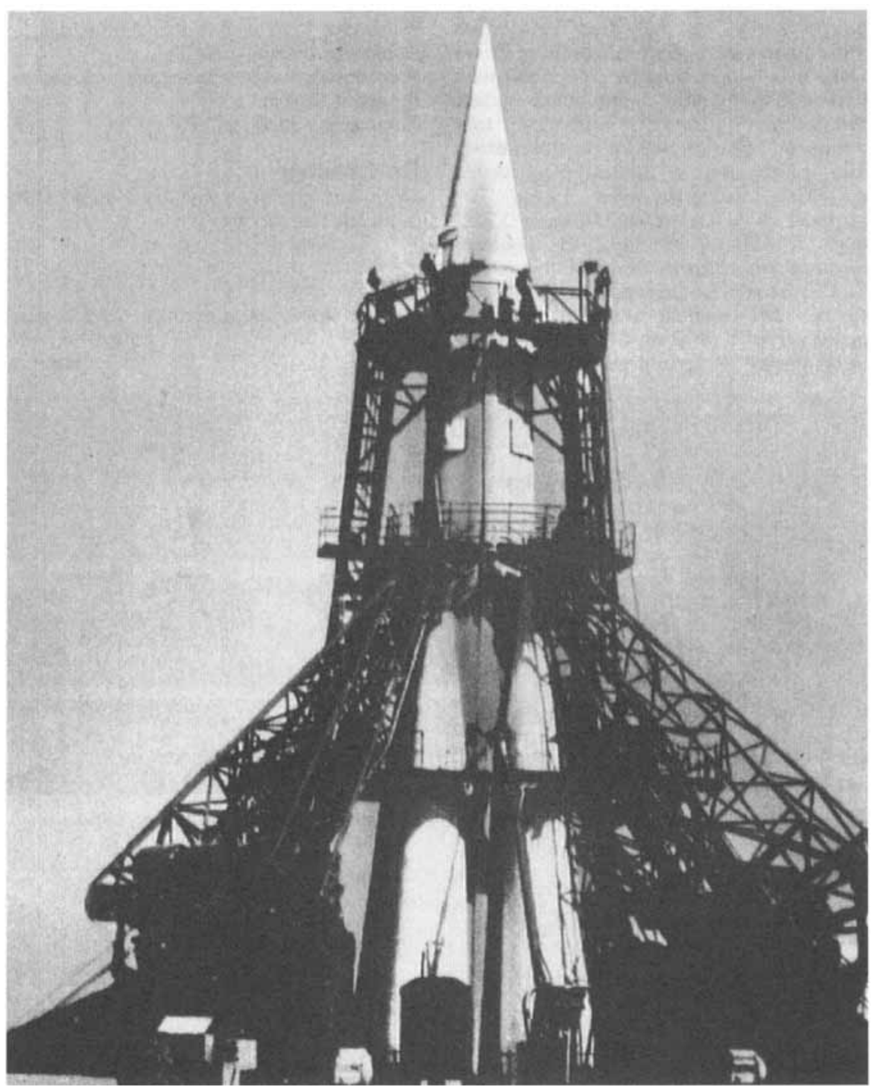
Length: 27.0 m
Body diameter: 2.95 m
Launch weight: 276,000 kg
Payload: Single warhead; 5,400 kg (R-7), 3,700 kg (R-7A)
Warhead: 5 MT nuclear (R-7), 3 MT nuclear (R-7A)
Guidance: Inertial
Propulsion: One stage liquid propellant
Range: 8,000 km (R-7). 9,500 km (R-7A)
Accuracy: 3,000 m CEP

Contractor

The SS-6 'Sapwood' was designed by the Korolyev Design Bureau (now NPO Energia).



***A line** diagram of **the SS-6** Sapwood' missile* 0044937



An SS-6 'Sapwood' (R-7) intercontinental ballistic inissile within its launch tower assembly prior to a trials launch

SS-7 'Saddler' (R-16/8K64)

Type
Intercontinental-range, surface-based, liquid propellant, single warhead ballistic missile.

Development
The SS-7 'Saddler' missile, Russian designation R-16 and 8K64, was one of the few Russian strategic missiles not seen in any of the Moscow parades. Little is known of the development of this second-generation intercontinental-range missile, and the few references that have been made to it have almost invariably bracketed it with the SS-8 'Sasin' missile. However, information released in the 1976 US Military Posture Statement appeared to resolve the confusion in the identification of the SS-7/SS-8 'twins'. It is now known that SS-7 'Saddler' was designed by the Yangel OKB and SS-8 'Sasin' by the Korolyev OKB.

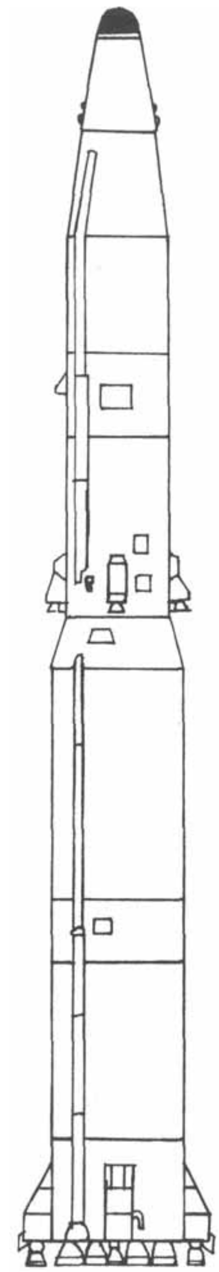
Development of the SS-7 is believed to have begun in the mid-1950s and the missile was first tested in 1960 and entered service in 1961. A report in 1995 indicated that an early trials SS-7 missile exploded in 1960 on the launch pad, killing 74 people. American official sources have identified Mod 1, Mod 2 and Mod 3 versions but have not indicated the differences between them. Russian official sources describe only two versions, the R-16 and R-16U, with the R-16U having an increased weight and range.

Description
The SS-7 'Saddler' (R-16) missile was 30.4 m long, had a first-stage body diameter of 3.0 m and a second-stage body diameter of 2.7 m. The missile had a launch weight of 140,600 kg. R-16 is believed to have carried a single separating 3 MT or 5 to 6 MT nuclear warhead with a payload (throw weight) of 1,750 to 2,200 kg. The missile used RD-218 and RD-219 motors with liquid oxygen and kerosene. The two-stage liquid propellant motors gave the missile a maximum range of 11,000 km and the accuracy is reported from Russia as being 2,700 m CEP. Guidance was inertial, with control through control vanes in the motor efflux nozzles and adjusting control motors. The first stage assembly had six motors, with four additional smaller control motors attached to outer flanged units. A similar four control motors were attached to the second stage motor assembly. Although the use of storable liquid fuel in the **SS-7** significantly reduced the preparation time needed to launch the missile, the guidance systems led to declining operational readiness when they were kept on alert. Early SS-7 missiles were deployed in above ground soft launch sites, some were deployed in semi-hardened horizontal shelters described as coffin-like revetments. The later missiles were deployed in Sheksna-N silos, with heavy steel and concrete doors. The R-16U missiles had an increased weight of 148,000 kg, and an increased range of 13,000 km. These missiles were placed in modified Sheksna-V silos. The payload, warhead yields and accuracy were the same as for the R-16 version.

Operational status
The SS-7, which was the first Russian ICBM to be deployed in quantity, entered operational service in 1961 in non-protected, above ground launch pads. The increased range R-16U version entered service in 1963. By the end of 1965, the SS-7 had reached its peak deployment of 186 missiles. This number started to decline in 1976 and all were retired by 1979 in accordance with the terms of SALT 1, so as to make room for new SLBM deployments.

Specifications
Length: 30.4 m
Body diameter: 1st stage 3.0 m, 2nd stage 2.7 m
Launch weight: 140,600 kg (R-16). 148,000 kg (R-I6U)
Payload: Single warhead 1,475 to 2,200 kg
Warhead: 3MT or 5 to 6 MT nuclear
Guidance: Inertial
Propulsion: 2-stage liquid propellant
Range: 11,000 km (R-16), 13,000 km (R-16U)
Accuracy: 2,700 m CEP

Contractor
SS-7 was desianed bv the Yangel Design Bureau (now– NPO Yuzhnoye) and manufactured by ASA Polyot.



A line diagram of the SS-7 'Saddler' ballistic missile 0044938

SS-8 'Sasin' (R-9/8K75)

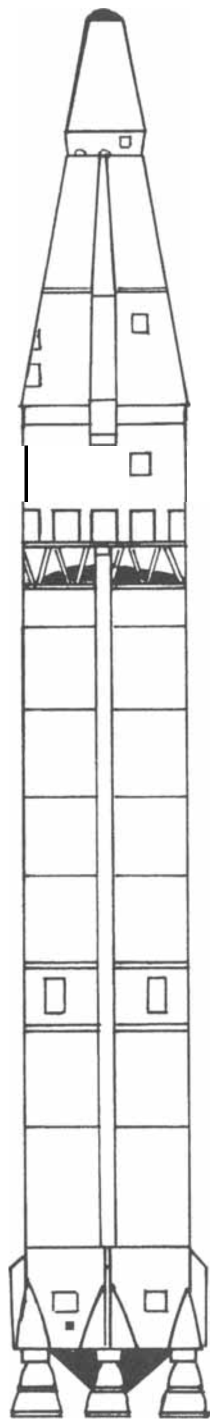
Type
Intercontinental-range, silo-based, liquid propellant, single warhead ballistic missile.

Development
A Russian article released in 1993 revealed to the West that the SS-8 'Sasin' carried the Russian designation R-9 (Devyatka) and 8K75. The SS-8 'Sasin' (R-9) was designed by Sergei Korolyev, who also designed the SS-6 'Sapwood' (R-7) which was Russia's first ICBM. Although the SS-6 performed well on space missions, it was not particularly well designed for an operational ICBM. As a result, Korolyev began work on a new design of missile. The programme became the SS-8, and government authorisation for development to commence was given in May 1959. There has been confusion for many years about the SS-8 (R-9) missile. It is possible that the Russians paraded a separate Yangel (now NPO Yuzhnoye) design with the designator R-26, which was given the NATO designator 'Sasin'. The R-26 was never put into production. Irrespective of later design changes in the SS-8 programme, two versions of the missile were built, each tailored for specific payloads. The first test flights were carried out in April 1961 with more being carried out through 1961 to 1964. The SS-8 'Sasin' entered service in 1965.

Description
The SS-8 'Sasin' (R-9) was a ground and silo-launched two-stage liquid propellant ballistic missile. In its original design, the first stage carried a single NK-9 four chamber engine, while the second stage carried a single NK-19 engine with a single main chamber and possibly four smaller vernier chambers. The first stage had a fairing round the engine nozzles and four small stabilisers. Between the first and second stage was an open-truss support frame. The overall length of the SS-8 was 24.19 m. The first stage was 14.79 m long with a body diameter of 2.68 m, and the second stage was 9.4 m long with the same body diameter. There is no information on the type of guidance system used but it was probably with radio command corrections during first stage boost and inertial operating on the control engines. The lighter version had a launch weight of 80,000 kg, carried a payload of 1,650 to 2,100 kg with a nuclear warhead having a yield of 1.65 to 3 MT or 5 MT. This version had a range of 10,300 km, and an accuracy of 1,600 m CEP. The heavier version had a launch weight of 82,000 kg, carried the same payloads, and had a range of 16,000 km with the same accuracy. The ground-launched missile was launched from a Dolina complex, and the silo-based version from a Desna-V complex.

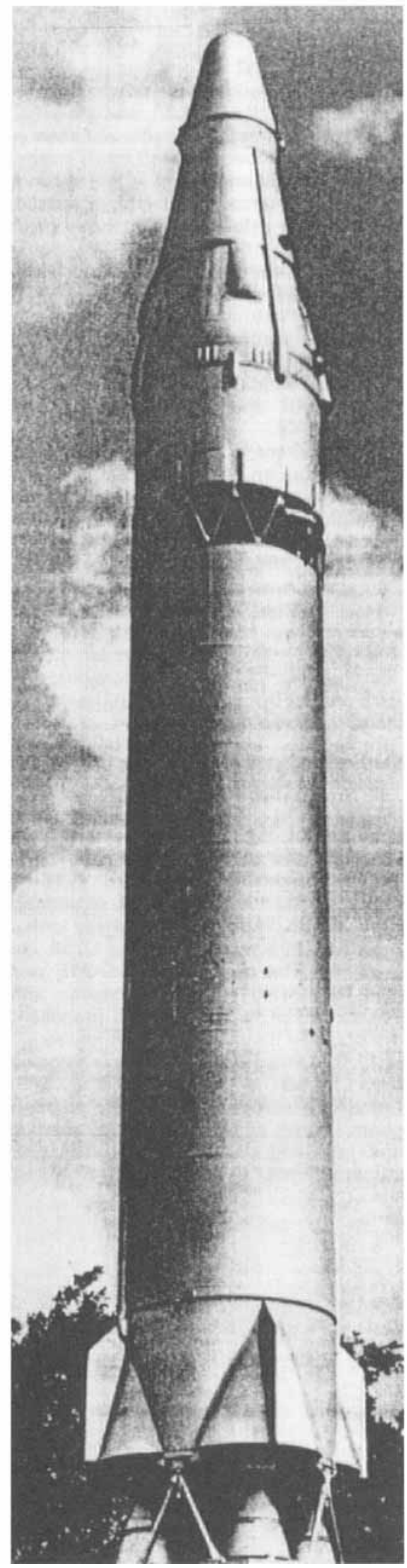
Operational status
Flight tests on the SS-8 'Sasin' were completed in 1964 and the missile system entered service in 1965. It is believed that around 25 missiles were deployed, and that these had been removed from service by 1978.

Specifications
Length: 24.19 m
Body diameter: 2.68 m
Launch weight: 80,000 or 82,000 kg
Payload: Single warhead; 1,650 to 2,100 kg
Warhead: 1.65 to 3 MT or 5 MT nuclear
Guidance: Inertial
Propulsion: 2-stage liquid
Range: 10,300 or 16,000 km
Accuracy: 1,600 m CEP



A line diagram of the SS-8 'Sasin' ballistic missile

Contractor
The SS-8 was designed by the Korolyev Design Bureau (now NPO Energia).



This is believed to be an SS-8 Sasin inissile (R-9)

SS-9 'Scarp' (R-36/8K67 and 8K69)

Type

Intercontinental-range, silo-based, liquid propellant, single or multiple warhead ballistic missile.

Development

The SS-9 'Scarp' missile, Russian designator R-36 and 8K67 or 8K69, was the first of the third generation of Russian intercontinental-range strategic missiles, following on from the second-generation systems SS7 'Saddler' and SS-8 'Sasin'.

The SS-9 was designed by the Yangel design bureau and was first publiclyshown during the Moscow parade in November 1967. Development of the SS-9 was started in the late 1950s. it was initially tested in 1963 and deployed in 1967. It is believed that the SS-9 was first intended to replace the SS-7 to attack large-area targets, but was later re-oriented to give the Russians their first 'hard target' capability against the US Minuteman ICBM force. In addition to the initial missiles (Mod 1 and Mod 2). two other SS-9 variants (the Mod 3 and Mod 4) were developed. The Mod 3 was a depressed-trajectory Fractional Orbital Bombardment System (FOBS). In all, some 22 SS-9 Mod 3 tests were conducted between 1965 and 1968 and the missile was deployed at Tyuratam beginning in 1969. The FOBS capability enabled Russia to threaten the USA from a southerly direction, with operational orbits as low as 150 km altitude; these would have been difficult to defend against. The SS-9 Mod 4 used a three warhead Multiple Re-entry Vehicle (MRV) and it was this design that was so important in the development of future MIRV systems in Russian strategic missiles. A Russian report in 1996 suggests that the SS-9 missile was the first to carry penetration aids. The SS-9 Mod 4 was tested 20 times between August 1968 and November 1970. There have been unconfirmed reports that there was also a Mod 5 developed that carried satellite killing payloads, but this has not been confirmed. The space launch vehicles SL-IO, SL-1 1 and SL-14 (Tysklon/Cyclone) were developed from the R-36 (SS-9) basic vehicle.

Description

In its day, the SS-9 'Scarp' was the largest and best known of the Russian strategic missile force. It was a two-stage liquid propellant ballistic missile that was 32.2 m long. The two stages had the same body diameter of 3.0 m but the separating re-entry vehicle had a distinctive long blunt nose. The first-stage propulsion system was also distinctive, with three motors and six main nozzles in the centre and four control motors on the diameter flaired into the outer skin with blunt squarish sub fins. This was similar to the SS-7 'Saddler' first stage. The second stage used a single motor with two combustion chambers. The missile had retro-rockets between the first and second stages and between the second stage and the re-entry vehicle, to ensure safe separation. The SS-9 missile had RD-251 and RD-252 motors, and used unsymmetrical dimethyl-hydrazine and nitrogen tetroxide fuel and oxidant, as these could be safely stored in the missile for several years. The SS-9 Mod 1 and 2 versions had a launch weight of 183,890 kg, and a range of 15,500 km. The Mod 1 missile had a payload of 3,950 kg and carried a nuclear warhead with a yield of 5 MT. The Mod 2 missile had a payload of 5,825 kg and carried a nuclear warhead with a yield of 10 MT. The Mod 3 missile, which was a FOBS, had a launch weight of 180,000 kg, a payload of 6,000 kg and a warhead with a yield of 5 MT. The Mod 4 missile had a launch weight of 183,000 kg, and a range of 12,000 km. This version had a payload of 6,000 kg and carried three MRV nuclear warheads each with a yield of 2 to 3 MT. Guidance was inertial operating on the control motors. The Russians give the accuracy of the Mod 1 and 2 versions as 1,200 m CEP. The SS-9s were deployed and fired from hardened silos, built in complexes of six with an additional command silo.

Two SS-9 'Scarp' liquid-propelled ICBMs on show in Moscow in 7972

Operational status

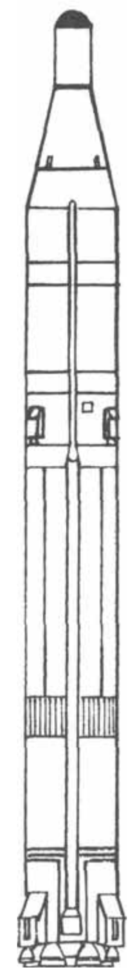
The SS-9 'Scarp' (R-36) Mod 1 and 2s entered operational service in 1967, the Mod 3 (FOBS) in 1968, and the Mod 4 in 1968. The Mod 1, 2 and 3 missiles reached a peak deployment of 255 in 1971 and the Mod 4 missiles reached a peak deployment of 100 in 1973. By 1979, all the SS-9 missiles had been taken out of service.

Specifications

Length: 32.2 m
Body diameter: 3.0 m
Launch weight: 183,890 kg (Mod 1 and 2), 180,000 kg (Mod 3). 183,000 kg (Mod 4)
Payload: Single warhead 3,950 kg (Mod 1), 5,825 kg (Mod 2). 6,000 kg (Mod 3), MRV with 3 warheads 6,000 kg (Mod 4)
Warhead: 5 MT (Mod 1 and 3). 10 MT (Mod 2). 2 to 3 MT nuclear each (Mod 4)
Guidance: Inertial
Propulsion: 2-stage liquid
Range: 15,500 km (Mod 1 and 2). 12,000 km (Mod 4)
Accuracy: 1,200 m CEP (Mod 1 and 2)

Contractor

The SS-9 was designed by the Yangel Design Bureau (now NPO Yuzhnoye).



*A line **diagram** of the SS-9 missile*

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SS-X-10 'Scrag' (GR-1/8K713 and UR-200/8K81)

Type
Intercontinental-range, silo-based, liquid propellant, single warhead ballistic missile.

Development
The third generation of Russian ICBMs included six missile types produced by several design bureau. Three became operational (SS-9 'Scarp', SS-1 1 'Sego' and SS-13 'Savage') and three were cancelled (SS-X-IO, SS-X-14, and SS-X-15). The SS-X-10 was developed from 1960 by the Korolyev design bureau and was tested concurrently with the SS-9 Mod 3 as a Fractional Orbital Bombardment System (FOBS), or depressed-trajectory mode missile. The Russian designators are believed to have been GR-1 and 8K713. The missile was first publicly shown in a Moscow parade in 1965, but after only eight test firings the programme was cancelled in 1968. It is believed that there were three designs submitted for the original SS-10 requirement; the GR-1 from Korolyev, an R-36 variant from Yangel and a UR-200 from Chelomei. The UR-200 (8K81) made nine test flights, but it is believed that the GR-1 was paraded in Moscow. It is unclear if the GR-1 was test flown, but it is believed to have been. Itwas reported in the mid-1960s that the SS-X-10 had been a sister vehicle of the one used for the Vostok and Voshkod spacecraft, SL-3 and this probably indicates that SS-X-10 was a development of the earlier SS-6 'Sapwood' design.

Description
The SS-X-10 (UR-200version) was a three-stage liquid propellant ballistic missile that was reported to have an overall length of 37.0 m. The three stages were separated with interstage fairings, whereas the GR-1 version had open truss interstages.

Two SS-X- 10 Scrag (GR-1 versions) liquid-propelled ICBM shown in Moscow in 1965 (John W R Taylor)

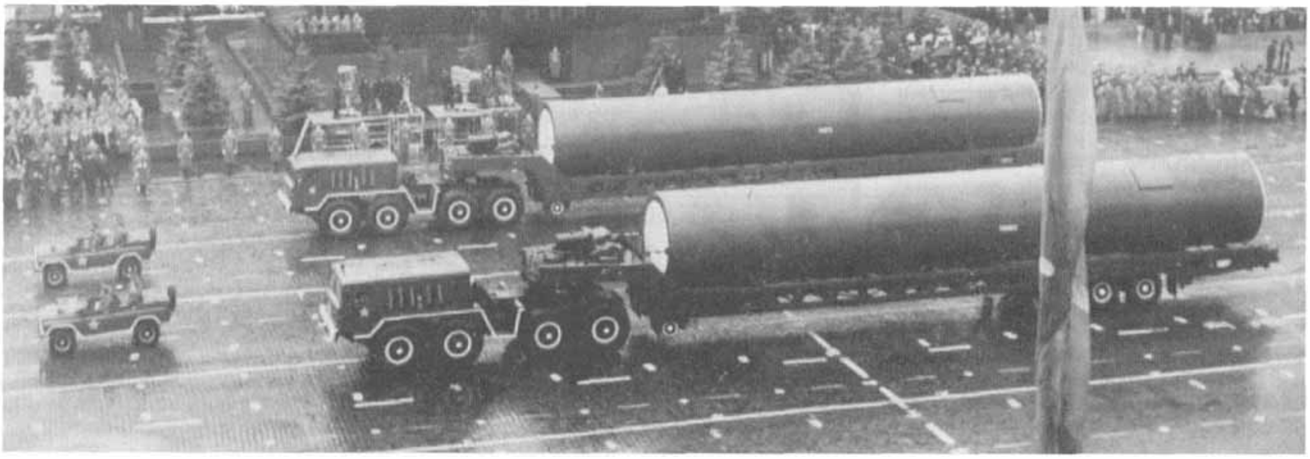
The first stage had a body diameter of about 3.0 m and had four gimbaled nozzles, the second and third stages had single nozzles, the second being very large and the third quite small. The missile could not be kept on alert for very long, due to the liquid propellants used, and this was reported to be the primary reason for the project's cancellation. Guidance was probably inertial. It would appear from reports that no warhead was ever fitted to the SS-X-IO. 'Global range' was claimed for the 'Scrag' missile when it was first shown and having regard to its size, the published estimate of 8,000 km range seemed rather conservative.

Operational status
The SS-X-10 'Scrag' (UR-200version) was only tested nine times during its development, and the programme was cancelled in 1968. It is unclear how many tests were made by the GR-1 version, or whether just the UR-200 was flown.

Specifications
Length: 37.0 m
Body diameter: 3.0 m
Launch weight: n/k
Payload: Single warhead
Warhead: Nuclear
Guidance: Inertial
Propulsion: 3-stage liquid
Range: 8,000 km
Accuracy: n/k

Contractor
The SS-X-10 (GR-1 version) was designed by the Korolyev Design Bureau (now NPO Energia), and the UR-200 version was designed by the Chelomei (now NPO Machinostroenie) Design Bureau.

SS-11 'Sego' (RS-10/UR-100/8K84/15A20)



Two SS-11 being transported in their launch canisters during a Moscow Parade

Type

Intercontinental-range, silo-based, liquid propellant, single warhead ballistic missile.

Development

Development of the SS-11 'Sego', known in Russia as RS-10 Mod 1 (8K84) or UR-100, commenced in 1954 with the first version entering service in 1965. This version had a single nuclear warhead. A second version, known in Russia as Mod 2 (15A20) or UR-100K, entered service in 1972. This had a single nuclear warhead and carried penetration aids. A third version, Mod 3 (15A20U) or UR-100U, entered service in 1974. This version had three MRV warheads. NATO designated four modifications for this missile, and it is believed that NATO Mod 1 and 2 refer to the Russian Mod 1, as this had two different warhead options.

Description

The SS-11 'Sego' ballistic missile was in the light ICBM category. The Mod 1 (UR-100) version had a length of 16.97 m, a body diameter of 2 m and a launch weight of 42,300 kg. It had a single 500 kT or 1.1 MT nuclear warhead in a re-entry vehicle with a throw weight of 1,208 or 1,600 kg, inertial guidance and two-stage liquid propellant motors using UDMH and nitrogen tetroxide. The first stage had four motors and the second stage one motor with four small control motors. The Mod 1 version had a range of 12,000 km and an accuracy of 1,400 m CEP.

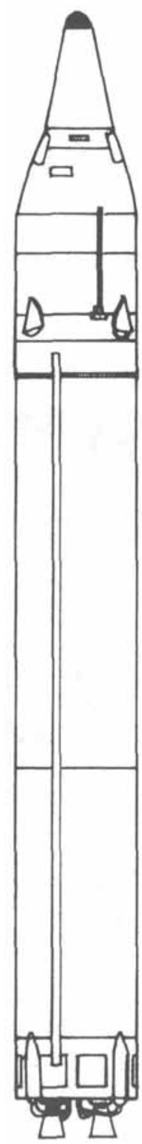
The Mod 2 (UR-100K) version had a launch weight of 50,100 kg, providing a range of 12,000 km and an improved accuracy of 1,000 m CEP. This version had a single 1.3 MT nuclear warhead in a re-entry vehicle with a throw weight of 1,200 kg and penetration aids. The Mod 3 (UR-100U) version was 18.95 m long and had a rounded nose, and had a launch weight of 51,240 kg, providing a range of 10,600 to 12,000 km. This version had three MRV, each with a 350 kT nuclear warhead. The throw weight was declared by the Russians in 1991 as 1,208 kg. The accuracy was 1,000 m CEP. The SS-11 missiles were launched from canisters in a silo, with ten silos per missile complex. The canisters were 19.5 m long, had a diameter of 2.9 m and an empty weight of 14,400 kg.

Operational status

The SS-11 'Sego' Mod 1 entered service in 1965, the Mod 2 version entered service in 1972, and the Mod 3 version in 1974. Deployment of the SS-11 reached 1,030 missiles in 1974, when all the missiles were Mod 2 or 3 versions. By 1981, there were some 500 remaining, as they were being withdrawn in favour of the later generation SS-17 and SS-19 missiles. Further reductions were made from 1985 to 1990 to compensate for SS-25 'Sickle' deployments, to keep within the Strategic Arms Limitation Treaty requirements. Russian reports in 1991 indicated that only single warhead Mod 2 missiles remained in service, with 326 missiles in silos in 1991. By July 1994 all the missiles and silos had been dismantled.

Contractor

Chelomei Design Bureau.



Line drawing of an SS-11 Sego' missile.
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Specifications

	SS-11 Mod 1 and 2	SS-11 Mod 3
Length	16.97 m	18.95 m
Body diameter	2.0 m	2.0 m
Launch weight	42,300 kg (1), 50,100 kg (2)	51,240 kg
Payload	Single warhead	3 MRV
Warhead	Nuclear 500 kT or 1.1 MT (1) or 1.3 MT (2)	Nuclear 350 kT each
Guidance	Inertial	Inertial
Propulsion	2-stage liquid	2-stage liquid
Range	12,000 km	10,600 to 12,000 km
Accuracy	1,400 m CEP (1), 1,000 m CEP (2)	1,000 m CEP

SS-12 'Scaleboard' (OTR-22/9M76 Temp)

An SS-12 'Scaleboard' missile in front of its TEL vehicle (Christopher F Foss) 0008587

Type

Short-range, road mobile, solid propellant, single warhead ballistic missile.

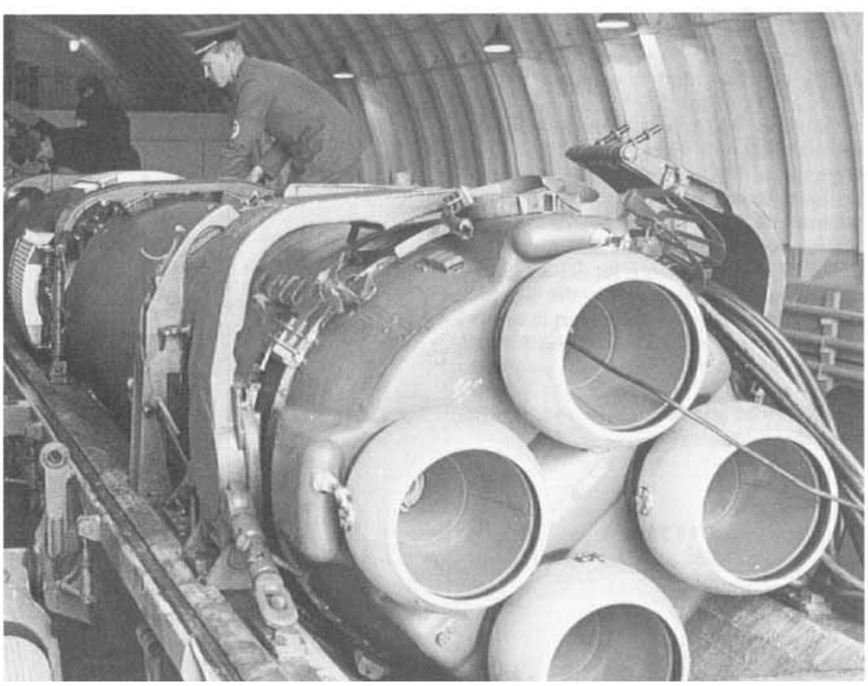
Development

The SS-12 missile, Russian designation OTR-22 (9M76) and named Temp, was deployed for some years in two versions. The first version SS-12A, was introduced in 1962, and a later version, designated SS-22 by NATO, deployed in 1979. The SS-22 was assigned a new designator in the belief that it was a new missile, but later this was realised to be a modification of the SS-12, and it was redesignated the SS-12B.

Description

The SS-12B missile had a length of 12.38 m, a diameter of 1.01 m and a launch weight of 9,400 kg. The diameter applies to the maximum dimension, including the strake, and the main structure diameter was 0.94 m. The photographs also show that there were four nozzles on each of the two-stage motors, and that directional control was achieved by actuators moving the outer nozzle shells. The missile had a throw weight of 1,250 kg, a maximum range of 900 km, and an accuracy of 1,000 m CEP. Propulsion was by two-stage solid propellant motors. Guidance was inertial in mid-course, with terminal homing. The SS-12B was the first of the generation of what were called 'reconnaissance-strike' missiles, that is, missiles capable of finding their own targets presumably by the utilisation of terminal homing. The SS-12B had been believed to carry only nuclear warheads, despite Russian indications to the contrary.

The missile was transported within a canister on a Transporter-Erector-Launcher (TEL) vehicle (9P76). This TEL was based upon the earlier 'Scud B' TEL (MAZ 543). and was a modified eight-wheeled MAZ-7910 chassis with a maximum road speed of 60 km/h; with the canister acting as the launch tube. The loaded vehicle weighed 39,000 kg, and there was a crew of five. Reaction time was estimated at 15 minutes.



A detail of the SS-12 engine nozzles and control actuators (US ACDA)

Operational status

The original SS-12A entered service in 1962. The SS-12B was introduced into service in Russia in 1979 and was deployed forward in Czechoslovakia and Germany from 1984 but there were no known exports. In November 1987, the Russians declared 85 missiles and 37 launcher vehicles as operational, with a further 633 missiles and 95 launcher vehicles non-deployed. The SS-12B was withdrawn under the terms of the 1987 INF Treaty and all missiles were destroyed.

Specifications

Length: 12.38 m
Body diameter: 0.94 m
Launch weight: 9,400 kg
Payload: Single warhead, 1,250 kg
Warheads: HE or 500 kT nuclear
Guidance: Inertial plus terminal
Propulsion: 2-stage solid
Range: 900 km
Accuracy: 1,000 m CEP

Contractor

Designed by the Nadiradze Bureau, and built at the Votkinsk Machine Building Plant, Udmert.

The SS-12B Scaleboard B missile in its canister on the transporter-erector-launcher vehicle

SS-13 'Savage' (RS-12/RT-2 and 8K98)

Type
Intercontinental-range, silo-based, solid propellant, single warhead ballistic missile.

Development
The Russian designation for the SS-13 is RS-12 (RT-2) or 8K98. The SS-13 was developed by the Nadiradze and Korolev Design Bureau, with work commencing in 1957. Initial deployment of the Mod 1 (8K98) began in 1968 and the Mod 2 (8K98P) in 1972. So far as is known, it had not been deployed with other than a single warhead. Russia stated that the SS-13 was the progenitor of the SS-25, and the SS-25 'Sickle' was given the Russian designator RS-12M. Both SS-13 and SS-25 are three-stage solid propellant missiles, with each stage a different diameter. The SS-13 was one of the early solid propellant missiles; it was successful, but was never deployed on a large scale.

Description
The SS-13 was an intercontinental-range, three-stage, hot-launched, solid propellant missile. The three stages of the missile shown are separated by truss structures and each has four nozzles. The upper stages are believed to be similar to the two stages of the SS-14 'Scapegoat', which was abandoned without deployment. The SS-13 Mod 1 missiles were 21.2 m long, the first stage had a body diameter of 1.84 m, the second stage 1.49 m and the third stage 1 m. The launch weight was 51,000 kg. The missile had a single 750 kT nuclear warhead within a re-entry vehicle with a throw weight of 600 kg, inertial guidance and a maximum range of 10,200 km. The accuracy was 1,300 m CEP.

The SS-13 Mod 2 was 21.35 m long and had a launch weight of 52,000 kg. This version had a 750 kT nuclear warhead, and a throw weight of 500 kg. The maximum range was 10,600 km, and the accuracy was improved to 1,100 m CEP.

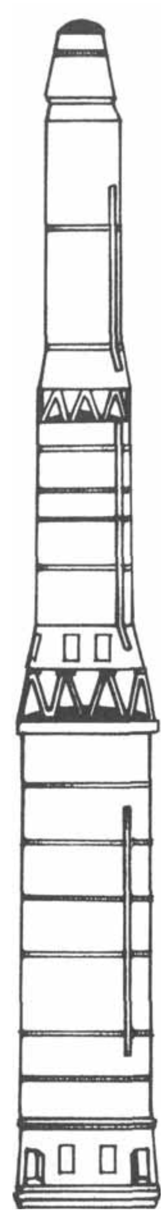
Both versions of SS-13 were hot launched, using first stage thrust, from their silos. The stage separation was achieved by the use of explosive bolts on the interstage truss structures. Control at launch was assisted by four paddle type control fins at the base of the first stage, a technique that was later applied to SS-21, SS-23, and SS-25 missiles. The missiles were in ten silo complexes.

Operational status
The SS-13 'Savage' Mod 1 version entered service in 1968 with Mod 2 entering service in 1972, and SS-13 missiles reached a peak deployment of 60 missiles in silos in 1974. The Russians test launched two SS-13 missiles in 1986, probably to show to the USA that the SS-13 and SS-25 missiles were related. In 1991, there were 40 silos at Yashkar-Ola in Russia; training facilities were located at Serpukhov and there were eight test silos at Plesetsk. A further 21 missiles were stored at Khrizolitovy. Following the Strategic Arms Reduction Treaty (START) agreements, only 20 missiles remained operational in December 1994 and by July 1995 all the missiles and silos had been dismantled.

Specifications
SS-13 Mod **1**
Length: 21.2 m
Body diameter: 1.84 m (1st stage), 1.49 m (2nd stage), 1.0 m (3rd stage)
Launch weight: 51,000 kg
Payload: Single warhead 600 kg
Warhead: 750 kT nuclear
Guidance: Inertial
Propulsion: 3-stage solid
Range: 10,200 km
Accuracy: 1,300 m CEP

SS-13 Mod **2**
Length: 21.35 m
Body diameter: 1.84 m (1st stage), 1.49 m (2nd stage), 1.0 m (3rd stage)
Launch weight: 52,000 kg
Payload: Single warhead 500 kg
Warhead: 750 kT nuclear
Guidance: Inertial
Propulsion: 3-stage solid
Range: 10,600 km
Accuracy: 1,100 m CEP

Contractor
Nadiradze and Korolev Design Bureau.



Line diagram of the SS-13 'Savage' missile
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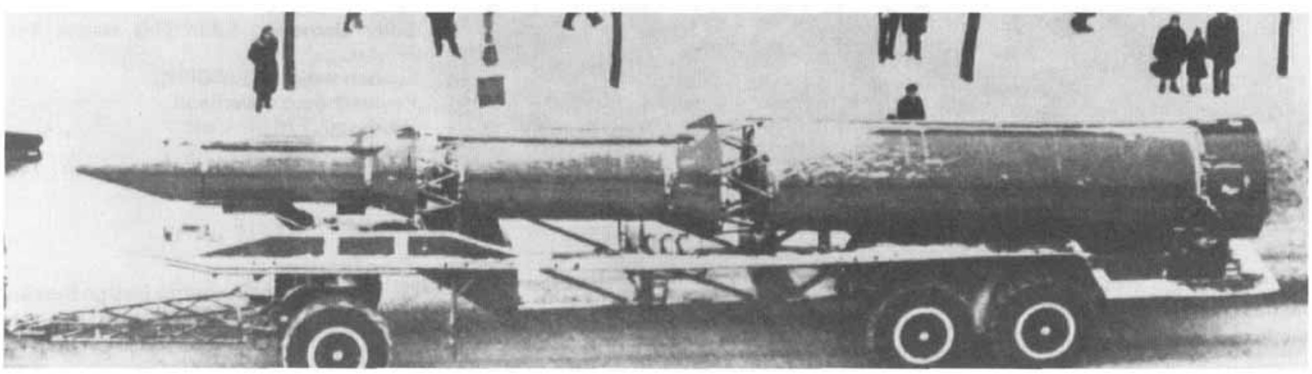


The SS-*13, first of the Russian solid propellant ICBMs*

SS-X-14 'Scapegoat'/'Scamp' (RT-I/8K96)

Type

Intermediate-range, road mobile, solid propellant, single warhead ballistic missile.

Development

The third generation of Russian ICBMs included six missile types produced by several design bureaux. Three became operational (SS-9'Scarp', SS-1 1 'Sego' and SS-13 'Savage'), and three were cancelled (SS-X-10. SS-X-14, and SS-X-15). The SS-X-14, Russian designator RT-1 and 8K96, was developed in the early 1960s as a mobile intermediate-range ballistic missile and is reported to have used the second and third stages of the SS-13 'Savage' missile. When the missile was first seen in public in 1965 it was enclosed in an all-concealing container known as the 'Iron Maiden'. From Russian official films it was learned that the missile inside was SS-X-14, then given the NATO name 'Scapegoat', which was publicly shown without its container in 1967. The complete weapon system comprising a 'Scapegoat' missile and its associated Transporter-Erector-Launcher (TEL) was given the NATO code-name of 'Scamp'. The SS-X-14 development programme was cancelled in 1970 after 19 tests. However, both the SS-X-14 and SS-X-15 are also reported to have been deployed briefly with active training units along the former Sino-Soviet border and later in western Russia.

Two SS-X-14 Scapegoat' solid propellant IRBM on dispersed launch stands
(John W R Taylor)

Description

The SS-X-14 'Scapegoat' was a land-mobile two-stage solid propellant ballistic missile that was reported to have an overall length of 10.6 m (including interstage). The first stage was 4 m long and had a body diameter of 1.4 m. The second stage was 3.5 m long and had a body diameter of 1 m. The nosecone and re-entry vehicle, that had a very blunt nose, was 2.30 m long and had a body diameter at base of 1 m. Guidance was probably inertial. The warhead used is thought to have been that used in the SS-13, which was in the order of 1 MT. The launch weight of SS-X-14 is believed to have been around 30,000 kg.

A prototype SS-X-14 Scamp mobile tactical inissile system on display in the 1965 Moscow parade

The missile was carried on the 'Scamp' tracked TEL in a sealed container that was hinged and split lengthways. Before firing, the missile (still in its container) was erected to the vertical firing position by a hydraulic jacking system at the rear of the 'Scamp' TEL. In the process, the cross-braced framework at the rear of the vehicle was lowered to the ground with the missile standing upright on it. The protective case was then removed to free the missile and leave it standing alone on its launch platform. The two stages of solid propellant motor are reported to have given the SS-X-14 an estimated range of 2,500 km.

Operational status

The SS-X-14 'Scapegoat' programme was cancelled in 1970 after 19 tests, including two crew training firings in 1969 and 1970.

Specifications

Length: 10.6 m
Body diameter: 1.4 m (1st stage); 1 m (2nd stage)
Launch weight: 30,000 kg
Payload: Single warhead
Warhead: 1 MT nuclear
Guidance: Inertial
Propulsion: 2-stage solid propellant
Range: 2,500 km
Accuracy: n/k

Contractor

Designed by the Nadiradze Design Bureau.

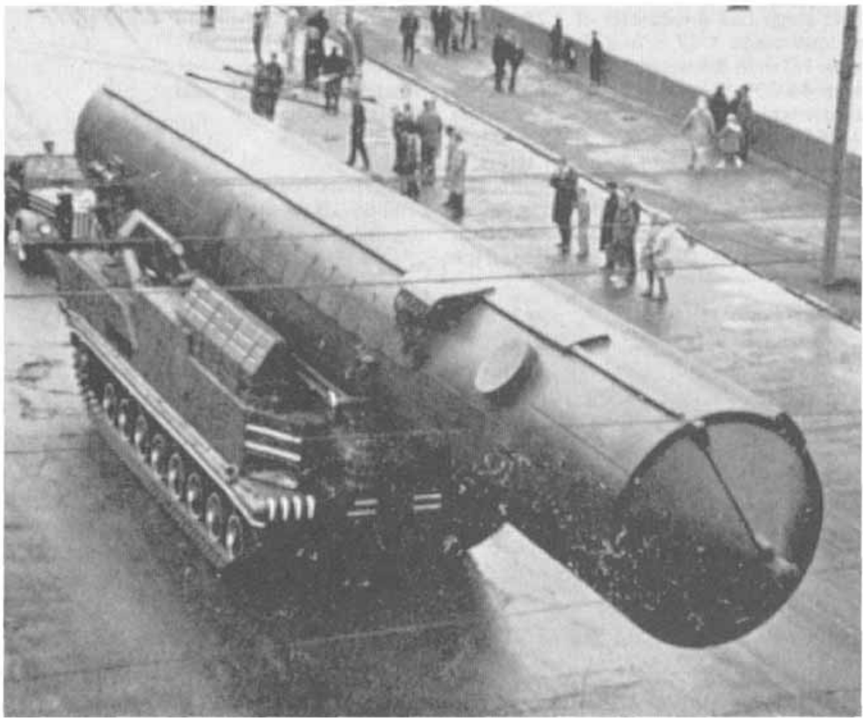
SS-X-15 'Scrooge' (RT-20/8K99)

Type

Intercontinental-range, road mobile, solid propellant, single warhead ballistic missile.

Development

The third generation of Russian ICBMs included six missile types produced by several design bureau. Three became operational (SS-9 'Scarp', SS-11 'Sego' and SS-13 'Savage') and three were cancelled (SS-X-IO, SS-X-14, and SS-X-15). The SS-X-15 missile, unlike SS-X-14, is believed to have been a new design, with a solid propellant first stage and a liquid propellant second stage. The missile, whose development started in the early 1960s was an attempt to develop a silo-based, railcar-based and road mobile ICBM. The Russian designator is believed to be RT-20 and 8K99. The SS-X-15 was first seen in public in 1965 during the Moscow parade, the missile itself being enclosed in a launch tube container carried on its own associated Transporter-Erector-Launcher (TEL), similar to that used by SS-X-14. The SS-X-15 was cancelled after eight research, development, test and evaluation firings, and was never operationally deployed. Although there are reports that both the SS-X-14 and SS-X-15 were deployed briefly with active training units along the former Sino-Soviet border and later in western Russia.



A prototype of the mobile SS-X-15 Scrooge ICBM on show in Moscow in 1965

Description

The SS-X-15 'Scrooge' was a land-mobile, two-stage, solid and liquid propellant ballistic missile. Details of the missile itself are not known other than reports that suggest that the second-stage liquid propellant motor was a 15D12, and that this motor was subsequently used in the SS-17 missile. The launch tube container was about 17.0 m long with a body diameter of around 2.0 m. It is estimated that the first stage had a length of 9.2 m, with a body diameter of 1.84 m, and the second stage had a length of 6.35 m with a body diameter of 1.0 m. The open truss structure between the two stages probably had a length of 0.7 m. The total missile length was 16.25 m. The missile launch weight is believed to have been 39,000 kg. Guidance was probably inertial. There were two warheads used with SS-X-15, a lightweight version with a weight of 545 kg and a yield of 550 kT, and a heavier version that had a yield of 1.5 MT and a throw weight of 1.410 kg. The missile was carried in a sealed canister on a tracked TEL. Unlike the SS-X-14, where the container split in half and was removed for firing, the SS-X-15 was raised to the vertical position and fired from the canister. The SS-X-15 had an estimated range of 6,000 km.

Operational status

The SS-X-15 'Scrooge' programme was cancelled in the early 1970s after only eight test firings.

Specifications

Length: 16.25 m
Body diameter: 1.84 m (1st stage); 1.0 m (2nd stage)
Launch weight: 39,000 kg
Payload: 545 or 1.410 kg
Warhead: 550 kT or 1.5 MT nuclear
Guidance: Inertial
Propulsion: 2-stage solid and liquid propellant
Range: 6,000 km
Accuracy: n/k

Contractor

SS-X-15 is believed to have been designed by the Yangel Desian Bureau (now NPO Yuzhnoye).

SS-16 'Sinner' (RS-14)

Type
Intercontinental-range, road mobile, solid propellant, single warhead ballistic missile.

Development
The SS-16 had the Russian designation RS-14. The SS-16 began development in 1964 and was the first Russian missile to carry the essential component of a MIRV system, a Post Boost Vehicle (PBV). All of the missiles in the following generation, which began in the early 1970s. carried the system. The capability implies the carrying of guidance computers on the PBV platform, for the accurate positioning and timing of the release of the re-entry vehicles.

The SS-16 was first flown from the Plesetsk test range in 1971 and deployment was anticipated in 1977. The missile however, became the centre of a dispute within the SALT 2 discussions as the first two stages of the missile form the SS-20 missile, a missile not constrained by the SALT treaties. The US was concerned that SS-20s could be stockpiled and then converted to SS-16s and there was also a concern that the two missiles would be difficult to distinguish during the verification process; the SALT agreement led to the discontinuation of both testing and deployment of the SS-16. This position was later challenged by the US, who claimed that modification and expansion of the SS-16 facilities took place after flight tests had been discontinued in 1976 and 1978 and they believe that there were SS-16s still deployed at Plesetsk up until 1985. Part of the US concern lay in the fact that the SS-16 has a PBV, a device normally included on missiles that are *to* carry multiple re-entry vehicles; they therefore suspected that there would be further development of the missile. It is not known when the SS-16 missiles were taken out of use.

Description
The SS-16 was a road mobile, three-stage, solid propellant, intercontinental-range missile. The missile was 18.5 m long, the first stage had a diameter of 1.79 m, the second stage 1.47 m and the third stage was 1.0 m in diameter. The launch weight was 44,000 kg and it is believed that the throw weight was 1,000 kg with a single 1MT yield nuclear warhead. The SS-16 had a range of 9,000 km. In broad terms, it resembled the US Minuteman 1 missile, except that SS-16 was road mobile. It was designed with both silo-based and road mobile versions; the silo design utilised the cold launch technique and the mobile version may have done so too. The cold launch technique utilised a gas generating Launch Assist Device (LAD) to eject the missiles from its silo; this prevents damage to the silo, enabling it to be rapidly refurbished for reuse.

Operational status
The US believed that there were 50 SS-16s deployed in silos at Plesetsk up until 1985. It is believed that there are no remaining SS-16s deployed and that the system is obsolete.

Specifications
Length: 18.5 m
Body diameter: 1st stage 1.79 m; 2nd stage 1.47 m, 3rd stage 1.0 m
Launch weight: 44,000 kg
Payload: Single warhead; 1,000 kg
Warhead: 1 MT nuclear
Guidance: Inertial
Propulsion: 3-stage solid
Range: 9,000 km
Accuracy: n/k

Contractor
The SS-16 was designed by the Nadiradze Design Bureau.

SS-I7 'Spanker' (RS-16 and 15A15/15A16)

Type

Intercontinental-range, silo-based, liquid propellant, Multiple Independently targetable Re-entry Vehicle (MIRV)capable ballistic missile.

Development

The Russian designation for the SS-17 was RS-16, 15A15 for the Mod 1 version and 15A16 for the Mod 2. The SS-17 Mod 1 began development in 1964, flight tests were carried out between 1972 and 1974, with initial deployment taking place in 1975. A second version, known as SS-17 Mod 2 (Russian designator RS-16B and 15A16) was introduced in 1980, with improved accuracy. The most important characteristic of this generation of Inter-continental-range Ballistic Missiles (ICBMs) was the introduction of an independent targeting capability for their multiple re-entry vehicles, making them genuine MIRV systems. The technique, which essentially enables one missile to cover a large area with a number of accurate warheads, had been introduced by the US in the 1960s on their Poseidon and Minuteman missiles.

All three missiles comprising this fourth generation, the SS-17, 18 and 19 were flight tested in versions with a single Re-entry Vehicle (RV), containing a high-yield nuclear warhead for use against very hard high-value targets. A single RV version was not produced for SS-17 missiles in service. The SS-17 and SS-19 were similar in specification, which has been interpreted as evidence of insurance on the part of the Russians that they would have at least one missile in the 'Minuteman' class to deploy in the 1970s.

Description

The SS-17 Mod 1 was a two-stage liquid propellant missile, 20.9 m long and 2.25 m in diameter. It had a launch weight of 71,100 kg, well within the Strategic Arms Limitation Treaty (SALT) limit for its class. The first stage was 14.3 m long with a body diameter of 2.25 m, and the second stage was 9.7 m long with a diameter of 2.1 m. The first and second stage used UDMH and nitrogen tetroxide propellants. The missile had four MIRVs and penetration aids, each with a variable yield 300 to 750 kT nuclear warhead, carried on a solid propellant powered bus vehicle with a throw weight of 2,550 kg. The SS-17 had inertial guidance and a maximum range of 10,200 km. The accuracy was 470 m CEP.

The Mod 2 version was slightly heavier at 72,000 kg launch weight, and had an increased range to 11,000 km and an accuracy improved to 350 m CEP. The four re-entry vehicles had penetration aids, and each MIRV warhead was variable between 500 and 750 kT. In 1991, the Russians declared a throw weight of 2,550 kg for this version. The SS-17 had a folding nosecone section, presumably because the original SS-11 silos were not deep enough to take the larger SS-17 missile. This nosecone folded forwards during the ejection sequence from the silo, to form an aerodynamic cone during the missile's transit through the atmosphere. The cold launch technique was used for ejection from the silo, using a solid propellant gas generator before the main, first stage, engine was ignited. The stages were separated using retrorockets.

Operational status

SS-17 Mod 1 missiles were initially deployed in 1975 in converted SS-11 silos, and the Mod 2 missiles were deployed from 1980. In 1991, there were 47 missile silos located at Vypolzovo (Yedrovo) in Russia, with only the Mod 2 version with four RVs remaining in service. Training facilities were at Balabanovo and there were four test silos at Leninsk. A further 101 missiles were stored at Surovatikha, Mikhaylenki and Pibanshur.

By December 1994, only 11 missiles remained operational, and by July 1996, all missiles and silos had been dismantled.

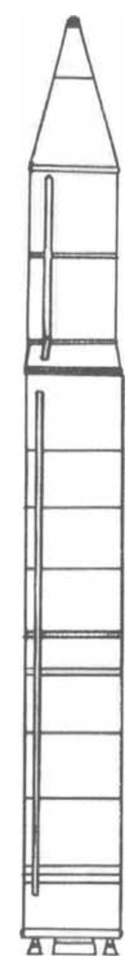
Specifications

SS-17 Mod **1**
Length: 20.9 m
Body diameter: 2.25 m
Launch weight: 71,100 kg
Payload: 4 × MIRV, 2,550 kg
Warhead: Nuclear 300 to 750 kT
Guidance: Inertial
Propulsion: 2-stage liquid
Range: 10,200 km
Accuracy: 470 m CEP

SS-17 Mod 2
Length: 20.9 m
Body diameter: 2.25 m
Launch weight: 72,000 kg
Payload: 4 × MIRV, 2,550 kg
Warhead: Nuclear 500 to 750 kT
Guidance: Inertial
Propulsion: 2-stage liquid
Range: 11,000 km
Accuracy: 300 m CEP

Contractor

Designed by the Yangel Design Bureau (OKB-586). with missiles built at Yuzhnoye NPO, Ukraine.



A line diagram of an SS-17 missile

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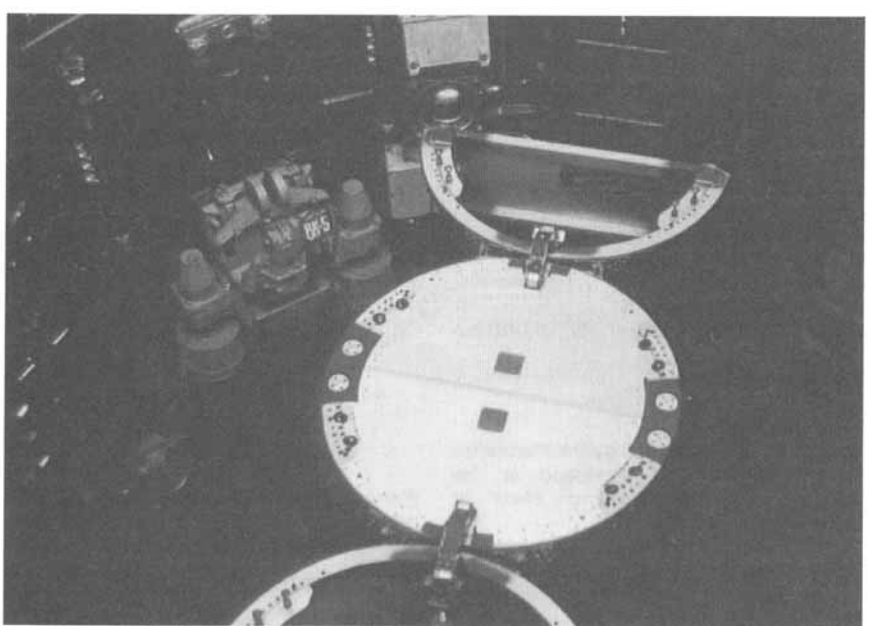


Thefolding nosecone section of the SS-17 shown at the top of the missile (Mark Urban)

SS-20 'Saber' (RSD-10 Pioner, 15Zh45)

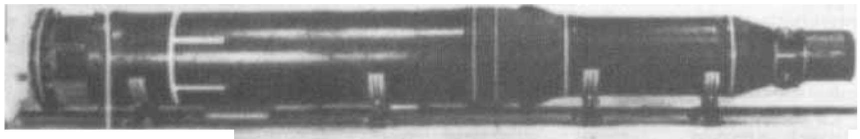
Type
Intermediate-range, road mobile, solid propellant, MIRV capable ballistic missile.

Development
The SS-20 missile had the Russian designation RSD-10 (15Zh45) and name *Pioner.* The SS-20 was essentially a mobile replacement for the fixed-based SS-4 and SS-5 systems. Development by the Nadiradze bureau began in 1966 and the missile entered service in 1976. SS-20 was believed to comprise the first two stages of the SS-16 ICBM, which was also a road mobile system, and the SS-20 may have been more of an opportunistic system than a role specific one. An early version was reported by the USA as having been tested with a single 50 kT nuclear warhead over a range of 7,400 km, but this version did not enter service. The first operational version had a range of 4,700 km, and the second version 5,000 km. A further version began flight testing in 1982. with an increased range and improved accuracy, but this was not put into service.

Description
The SS-20 was a two-stage, solid propellant, mobile IRBM The missile was 16.49 m long, with a base (first stage) diameter of 1.79 m, and a second stage diameter of 1.47 m. The launch weight of the missile in its canister was 42,700 kg and the weight of the missile alone was 37,100 kg. The first stage was controlled by extending lattice fins, similar to those used on the SS-13, SS-21, SS-23 and SS-25 ballistic missiles. The second stage was controlled by low temperature gas, injected into the motor nozzle. The maximum range capability was 4,700 km for Mod 1 and 5,000 km for Mod 2, and both had a minimum range of 600 km. SS-20 had three MIRV, and each RV carried a 150 kT yield nuclear warhead. The total throw weight was 1,740 kg.

The PBV inherited from the SS-16 was the first designed and built by the Russians. The PBV differs considerably from Western designs, with swivel thruster nozzles and the re-entry vehicles buried deep in the body of the PBV itself. The RVs were a single conic design, 1.6 m long and 0.64 m base diameter. The RVs had a nose radius of 11 cm and a cone half angle of 7.5°. The accuracy reported by the Russians was 550 m CEP.

The SS-20 Transporter-Erector-Launcher (TEL) had a prime mover derived from the MAZ-543 'Sud-B' TEL, but a larger version designated 15U67 (itself based on the 12 × 12 MAZ-547V vehicle chassis). The TELs were based in purpose-built concrete shelters with sliding roofs to permit launch of the missiles from inside the shelter. The missiles could also be launched from pre-surveyed entrenchments located around the base itself.



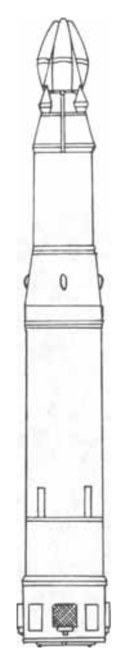
The SS-20 'Saber' missile, showing the outline of the post-boost vehicle at the nose, but without the three re-entry vehicles fitted

An SS-20 'Saber' TEL with a missile canister (Christopher F Foss) 0008588

Operational status
SS-20 'Saber' (RSD-10) entered service in 1976. At the time of the INF signing in 1987, the Russians reported 405 deployed missiles, with a further 245 non-deployed. A total of 29 separate locations, some with as many as five operating bases within them, were notified. All the missiles were destroyed by May 1991. Some SS-20 bases have been converted to accommodate the mobile version of the SS-25.

Specifications
Length: 16.49 m
Body diameter: 1st stage 1.79 m; 2nd stage 1.47 m
Launch weight: 37,100 kg
Payload: 3 RVs in MIRV configuration
Warhead: 150 kT nuclear each
Guidance: Inertial
Propulsion: 2-stage solid
Range: 4,700 km (Mod 1). 5,000 km (Mod 2)
Accuracy: 550 m CEP

Contractor
The SS-20 was designed by the Nadiradze Design Bureau and produced at the Votkinsk Machine Building Plant at Udmurt.

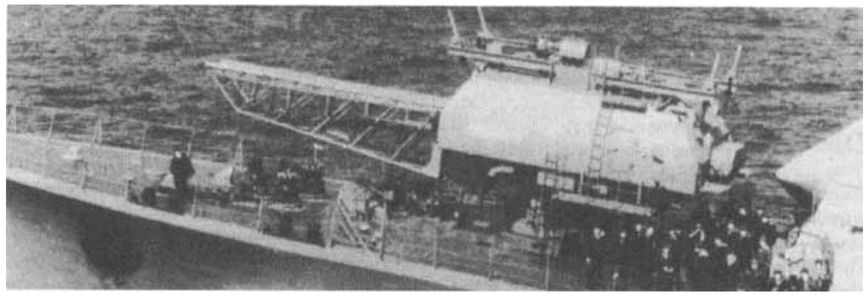


A line diagram of the SS-20 'Saber' ballistic missile 0044940

SS-N-I 'Scrubber' (P-1 Kssh)

Type
Short-range, ship-launched, single warhead surface-to-surface missile.

Development
The SS-N-1 'Scrubber'was the first Russian anti-ship, surface-to-surface missile and is reported to have had the Russian designator P-1 and the name Kssh. Little is known of the missile's development other than it was reportedly brought about by the failed attempt by the Russiansto adapt the ground-launched SSC-2b 'Samlet' missile for fitment to a 'Sverdlov' class cruiser. The SS-N-1 was developed to carry both conventional HE and nuclear warheads. The missile was tested in the mid-1950s and became operational in 1958 on four 'Kilden' class destroyers, which carried six missiles and a single launcher. From 1960, it was also deployed on the 'Krupny' class destroyers.



A 'Krupny' class destroyer fitted with an SS-N-1 Scrubber'launcher

Description
There are few description details of the SS-N-1 'Scrubber' available, other than like most other first generation missiles, it was large, relatively unsophisticated, had a short range, was inaccurate and designed primarily for anti-ship missions. It is believed that the missile was 7.6 m long, had a body diameter of 0.9 m, and a 4.6 m wing span. The missile had a cylindrical body, with a jet engine and warhead mounted beneath the body, and a solid propellant boost motor below the jet engine. There were two delta wings with turned-down tips, and four tailplanes. The SS-N-1 launch weight is believed to have been 3,100 kg, including the boost motor assembly, which was jettisoned after use. The missile apparently had at least one unusual feature; according to an observer during a trial "On approach to the target, a suspended warhead separated, descended several metres into the water and was supposed to strike the underwater part of the targets hull while the remainder of the missile struck above water". It is reported that the SS-N-1 had both nuclear and conventional warhead options, with a warhead weight of 730 kg. The missile had a maximum range of about 40 km.

Operational status
SS-N-1 'Scrubber' entered service in 1957 but was never widely deployed because of its low reliability and poor accuracy. It was retired from operational service by the late 1970s.

Specifications
Length: 7.6 m
Body diameter: 0.9 m
Launch weight: 3,100 kg
Payload: Single warhead, 730 kg
Warhead: HE or nuclear
Guidance: Inertial
Propulsion: Jet engine and solid propellant boost
Range: 40 km
Accuracy: n/k

Contractor
It is believed that SS-N-1 was designed by the Chelomei design bureau.

SS-N-4 (R-13/4K50)

Type

Intermediate-range, submarine-launched, liquid propellant, single warhead ballistic missile.

Development

The SS-N-4 was the first Russian ballistic missile designed exclusively for naval application and is believed to have been designated R-13 and 4K50 by the Russians. There were confused NATO designators, and it is not known what name was finally given to SS-N-4. The earlier D-1 submarine-launched ballistic missile system, using the R-11FM (Scud-IA) missile was first tested in 1955 and became operational in 1959. In 1956, the Russians started the development of a successor, known as R-13 (SS-N-4). as part of the D-2 submarine-launched ballistic missile system for carriage in their first nuclear-powered submarines. The first flight test of a SS-N-4 missile was made in 1960. The missile entered service in 1963 in the diesel-powered 'Golf' class (project 629) and the Russians first nuclear-powered ballistic missile submarine (SSBN), the 'Hotel' class (project 658). with three SS-N-4 missiles in each. There are unconfirmed reports that SS-N-4 design plans were passed to China in 1959.

Description

The SS-N-4 missile was 11.8 m long, had a body diameter of 1.3 m and a launch weight of 13,600 kg. The propellants were AK-271 fuel and TG-02 oxidant. The dry missile weight was 3,730 kg and a single warhead with a throw weight of 1,598 kg carried a 1 MT yield nuclear weapon. The warhead assembly separated from the single-stage liquid-fuelled motor assembly after boost. The four fins had a span of 1.91 m, and the missile was controlled by four small vernier motors mounted around the central motor nozzle assembly. Guidance was inertial.

The SS-N-4 had a maximum range of 560 km and an accuracy (according to the Russians) of 4,000 m CEP. The missiles were cold launched, and could only be fired with the submarine on the surface. The later missiles could remain combat-ready for six months.

Operational status

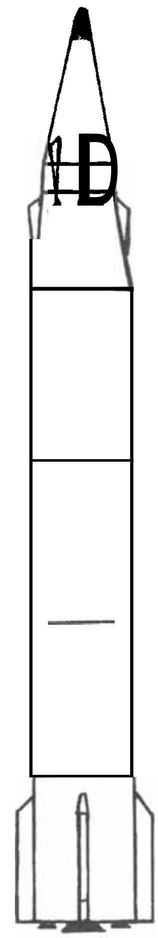
The SS-N-4 entered service in 1963. In 1965, there were 23 'Golf 1' SSBs and eight 'Hotel 1' SSBNs each with three SS-N-4 missiles. It is reported that 66 missiles were operationally deployed between 1962 and 1965, and that the final missiles were taken out of service in 1979. Between 1960 and 1972 there were 311 test launches, with 225 reported as successful.

Specifications

Length: 11.8 m
Body diameter: 1.3 m
Launch weight: 13,600 kg
Payload: Single warhead, 1,598 kg
Warhead: 1 MT nuclear
Guidance: Inertial
Propulsion: Liquid single-stage
Range: 560 km
Accuracy: 4,000 m CEP

Contractor

SS-N-4 was designed by the Makeyev (SKB-385) design bureau.



*Line diagram of **the SS-N-4** SLBM*
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SS-N-5 'Sark' (R-21/4K55)

Type
Intermediate-range, submarine-launched, liquid propellant, single warhead ballistic missile.

Development
The SS-N-5 was a Polaris generation missile, with the NATO codename 'Sark', and the Russian designators R-21 and 4K55. The missile system was known as the Russian D-4. It can be described as being in the second generation of Russian SLBMs, as it was the first to be launched from a submarine below the surface. It differed from Western design practice in a number of ways; principally in its mode of launch, which used a cold launch device to eject the missile from the launch tube. Development of the SS-N-5 began in 1959 and it entered service in 1963. The Russian Navy 4th Research Institute had conducted trials of underwater missile launch systems from 1955, but the first successful launch from a trials submarine was not made until 1960. The first flight test of an SS-N-5 missile was made in 1962. The missiles were retro-fitted in some 'Golf' class (project 629) submarines, and in 'Hotel' class (project 658) SSBN, with three missiles per boat.

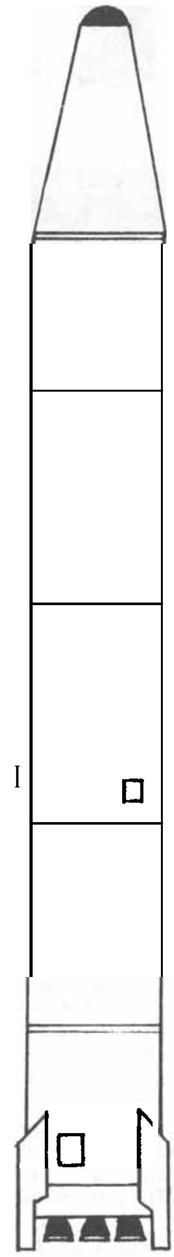
Description
The SS-N-5 (R-21) was a single-stage, liquid propellant, intermediate-range missile, 14.21 m in length and 1.3 m in diameter. Launch weight was 19,653 kg and the maximum range was 1,420 km. The missile carried a single re-entry vehicle with either an 800 kT or a 1 MT yield nuclear warhead within a re-entry vehicle with a throw weight of 1,180 kg. The missile had inertial guidance, and the accuracy was estimated at 2,800 m CEP.

At the base of the missile was a cluster of six nozzles through which cold gas was passed to eject the missile; on passing clear of the submarine this section was jettisoned from the main missile body when the first stage ignited. The missile could be launched from depths down to 45 m. This type of launch assist devices was common in Russian land-based missiles, and is used in the US ICBM, the LGM-118 Peacekeeper.

Operational status
The SS-N-5 was operational in the later 'Golf' class diesel submarines from 1963, and in the 'Hotel' class (nuclear) boats. As a sea-based intermediate-range missile, the SS-N-5 was unaffected by the conditions of the 1987 INF Treaty, but it is believed that by 1983 the missiles and submarines were beginning to be replaced. By 1988 there were none left in service.

Specifications
Length: 14.21 m
Body diameter: 1.3 m
Launch weight: 19,653 kg
Payload: Single warhead 1,180 kg
Warhead: 800 kT or 1 MT nuclear
Guidance: Inertial
Propulsion: Single-stage liquid
Range: 1,420 km
Accuracy: 2,800 m CEP

Contractor
SS-N-5 was designed by the Makeyev Design Bureau.



***Line diagram** of the SS-N-5 SLBM*
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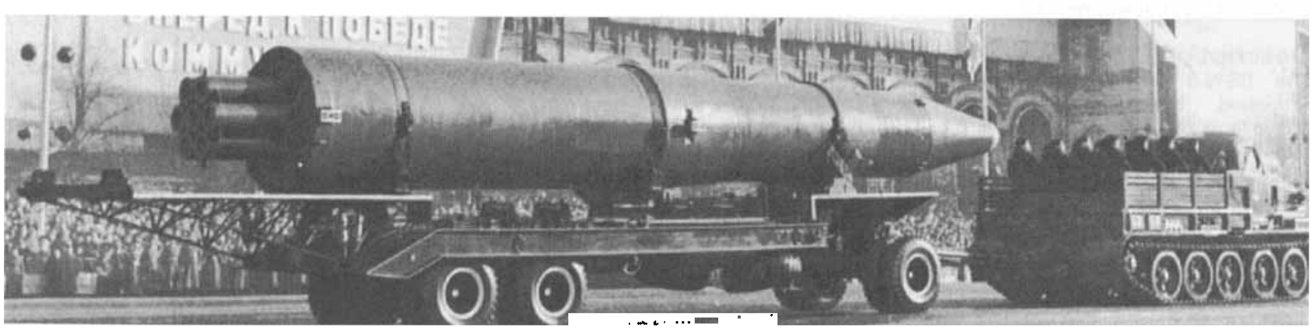
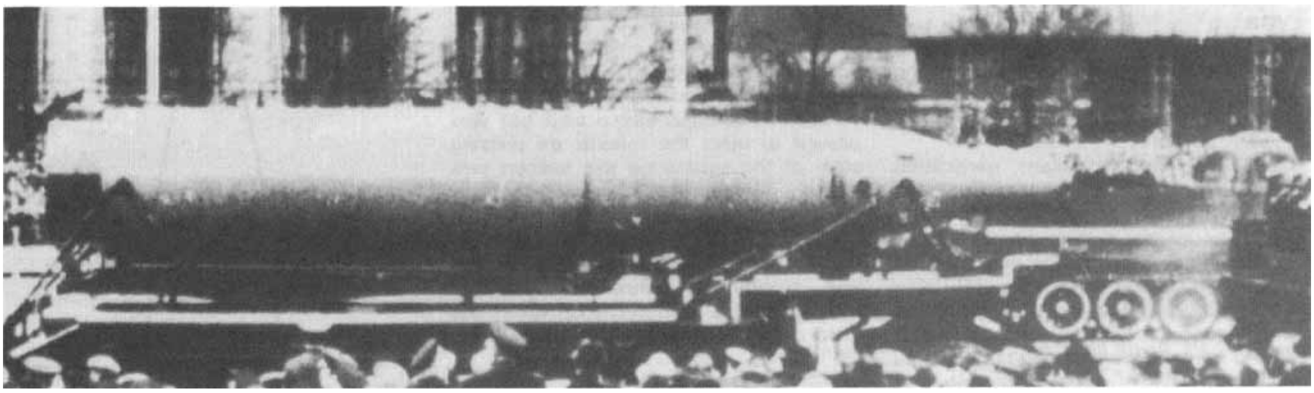


SS-N-5 Sark being paraded on a traiisporter vehicle. showing the launch device at the missile base

SS-N-6 'Serb' (RSM-25 Zyb/R-27/4K10)



The SS-N-6 'Serb' missile on a transporter vehicle

Type
Intermediate-range, submarine-launched, liquid propellant, Multiple Re-entry Vehicle (MRV) capable ballistic missile.

Development
The SS-N-6 missile had the Russian designation RSM-25 or R-27 (4K10), and was called Zyb. The complete system was known as D-5. The SS-N-6 was a product of the Makeyev Design Bureau; development began in 1958 and the missile entered service in 1968. A second modification, R-27M, with increased range, began flight tests in October 1972 and entered service in 1974. The third version, the Mod 3, carried three Re-entry Vehicles (RVs) in MRV configuration, and also entered service in 1974. The SS-N-6 missiles were fitted in 'Yankee' class (project 667A) submarines with 16 launch tubes each. The R-27M (Mod 2 and 3) was fitted in upgraded 'Yankee' boats (project 667AU) with 16 launch tubes each. A report in 1999 suggested that a single warhead anti-radar version had also been developed, with a reduced range of 900 km, and with a passive radar seeker to track ship surveillance radars during the terminal phase. The Russians gave this version the designator R-27K, and it was to have been fitted to Golf class submarines (Project 629). The project was cancelled in 1975. The Russian report indicated that the NATO designator for this missile was SS-NX-13, but this has not been confirmed.

Description
The SS-N-6 was a two-stage, liquid propelled, intermediate-range missile, 9.0 m long and 1.5 m in diameter. It had a launch weight of 14,200 kg. The Mod 1 had a range of 2,500 km, the Mod 2 and Mod 3 had a range of 3,000 km. The single re-entry vehicles Mods 1 and 2 carried a 1 MT warhead; the Mod 3 carried three 200 kT warheads. Guidance was inertial. The Mod 1 version had an accuracy of 1,900 m CEP, and the Mod 2 and 3 versions an accuracy of 1,300 m CEP. In 1991, the Russians declared the throw weight of SS-N-6 as 650 kg. The missile used storable liquid propellants, with a pre-launch preparation time of 10 minutes, and a launch interval of 8 seconds between launches.

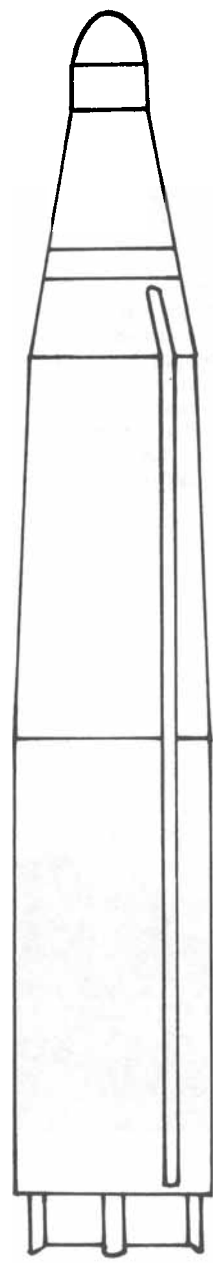
The R-27K version for attacking ship surveillance radars, had a length of 9.0 m, a body diameter of 1.5 m and a launch weight of 13,250 kg. The passive radar seeker was added to the warhead assembly, and presumably a smaller nuclear warhead was fitted. This missile had a range of 900 km.

Operational status
The SS-N-6 entered service in 1968, the Mod 2 and 3 in 1974. Deployments in 1991 were of the single warhead Mod 2 version, on the 'Yankee 1' boats, which carried 16 missiles each and were believed to have the Russian name Navaga. A total of 600 missiles were built and at its peak the SS-N-6 missile force was carried on 34 boats. In 1991, there were 12 'Yankee 1' boats operational, with 192 missiles. All the 'Yankee 1' submarines were based in Russia, at Yagelnaya (6 boats), Rybachiy (3) and Pavlovskoye (3). Further missiles were stored at these operational bases as well as at Revna and Okolnya, making a total of 419 SS-N-6 available for use. In addition, a further 88 missiles were at the Pashino conversion/elimination facility. By December 1994, only two 'Yankee 1' boats and 32 missiles remained in service, located at Rybachiy. One boat was decommissioned in 1995, and the second boat in 1996.

The anti-radar R-27K version was developed, but did not enter operational service, and the project was cancelled in 1975.

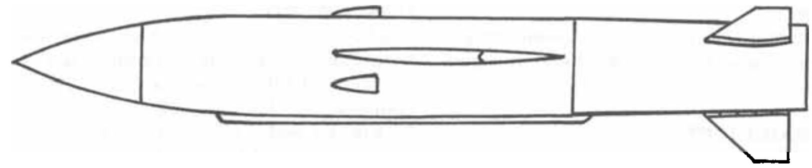
Specifications
Length: 9.0 m
Body diameter: 1.5 m
Launch weight: 14,200 kg
Payload: Single warhead (Mod 1 and 2). 3 MRV (Mod 3)
Warhead: 1 MT nuclear (Mod 1 and 2), three 200 kT nuclear (Mod 3)
Guidance: Inertial
Propulsion: 2-stage liquid propellant
Range: 2,500 km (Mod 1), 3,000 km (Mod 2 and 3)
Accuracv: 1.900 m CEP (Mod 1). 1.300 m CEP (Mods 2 and 3)

Contractor
The SS-N-6 was designed by the Makeyev Design Bureau.



A line diagram of the SS-N-6 'Serb' missile

SS-N-7 'Starbright' (P-20L Ametist/4K66)



*A line diagram of the **SS-N-7** 'Starbright'missile*

Type

Short-range, submarine-launched, solid propellant, single warhead surface-to-surface missile.

Development

The SS-N-7 'Starbright' was developed in the 1960s. and was the first generation of Russian anti-ship, surface-to-surface missiles capable of launch from a submerged submarine. It is believed that the missile was a modification of the SS-N-2 'Styx' (P-15/20/21/22/27) design, primarily an improved SS-N-2C (P-21) with an optional nuclear warhead. The Russian designator for the SS-N-7 was believed to be P-20L (or 4K66) and named Ametist. The SS-N-7 was reported fitted to 'Charlie 1' and 'Papa' class submarines, with eight missiles per 'Charlie' boat and 10 per 'Papa'. The SS-N-9 'Siren' is believed to have replaced the 'Starbright' missiles.

Description

The SS-N-7 was believed to be 7.0 m long, with a body diameter of 0.55 m and a launch weight of 2,950 kg. It was reported that the missile had autopilot mid-course guidance, with an active radar X-band (8-10 GHz) terminal seeker. The warhead was believed to be 513 kg, with conventional High Explosive (HE) and nuclear options. The missiles were located in inclined ramp housings inside the boats, with flush deck mounted hatches. At launch a twin pack solid propellant boost motor assembly accelerated the missile off the launch ramp. The missiles could be launched from the submerged position. It was believed that folding wings and fins were deployed on leaving the ramp. A liquid propellant motor was reported to give the SS-N-7 a range of 60 km, with a cruise speed of M0.95. Later versions had an increased range of 80 km, and flew at around 50 m altitude.

It was reported that the submarines used passive (ESM) target location (NATO designator 'Bald Head') and a surface target search radar (NATO designator 'Snoop Tray') to obtain range before submerging and running in towards the target and launching the missiles.

Operational status

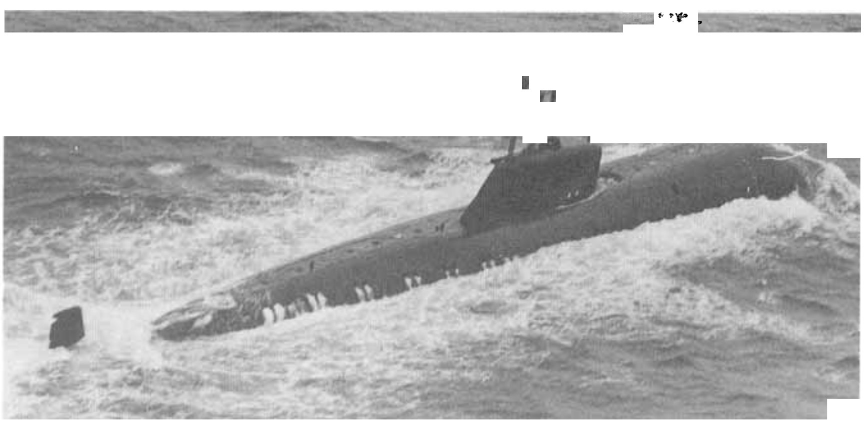
The SS-N-7 'Starbright' entered service with the Russian Navy in 1959, with improved versions operational in 1960 and 1967. In 1991, it was believed that only 100 'Starbright' missiles remained in service on 10 'Charlie 1' class Nuclear Powered Cruise Missile Submarines (SSGNs), but these boats had all been decommissioned by 1995. An unconfirmed report suggested that SS-N-7 missiles had been sold to India as part of the lease of a 'Charlie 1' boat from 1988 to 1991, but this has not been confirmed.

Specifications

Length. 7 0 m
Body diameter: 0 55 m
Launch weight 2,950 kg
Payload Single warhead, 513 kg
Warhead: HE or nuclear
Guidance: Autopilot with active radar
Propulsion: Liquid propellant with solid booster
Range: 60 km or 80 km
Accuracy: n/k

Contractor

Chelomei design bureau.



***A** Russian 'Charlie I' submarine, which could carry eight SS-N-7 'Starbright' missiles*
0038284

SS-N-17 'Snipe' (RSM-45/R-31/3M17)

Type

Intermediate-range, submarine-launched, solid propellant, single warhead ballistic missile.

Development

The SS-N-17 was one of the two second generation SLBMs to appear in the mid-1970s. and was Russia's first SLBM to utilise solid propulsion. The Russian designators were RSM-45, R-31 and 3M17, and the missile system was D-11. Development began in 1967, with testing first taking place from a converted 'Yankee 2' (project 667AM) submarine in 1974. The boat carried 12 missiles.

The SS-N-17 was also the first Russian SLBM to carry a PBV, implying an intention to produce a MIRV version; however, the absence of both a MIRV version or extensive employment indicates that the missile failed to live up to expectations and was overtaken by the more successful later designs of both solid- and liquid-propelled missiles.

Description

The SS-N-17 (R-31) was a two-stage, solid propellant, intermediate-range, ballistic missile, 11.99 m long and 1.72 m in diameter. It had a launch weight of 26,800 kg and a range of 3,900 km. The missile was cold launched. Guidance was inertial. The missile was believed to be fitted with a PBV, but carried a single 500 kT nuclear warhead re-entry vehicle with an estimated accuracy of 1,400 m CEP. In 1991 the Russians declared a throw weight of 450 kg for SS-N-17.

Operational status

The SS-N-17 was deployed on a single 'Yankee 2' boat, with 12 launch tubes, probably simply an opportunistic deployment of a development system in 1980. In 1991 the 'Yankee 2' boat was located at Yagelnaya, with an additional five missiles in storage at Revna.

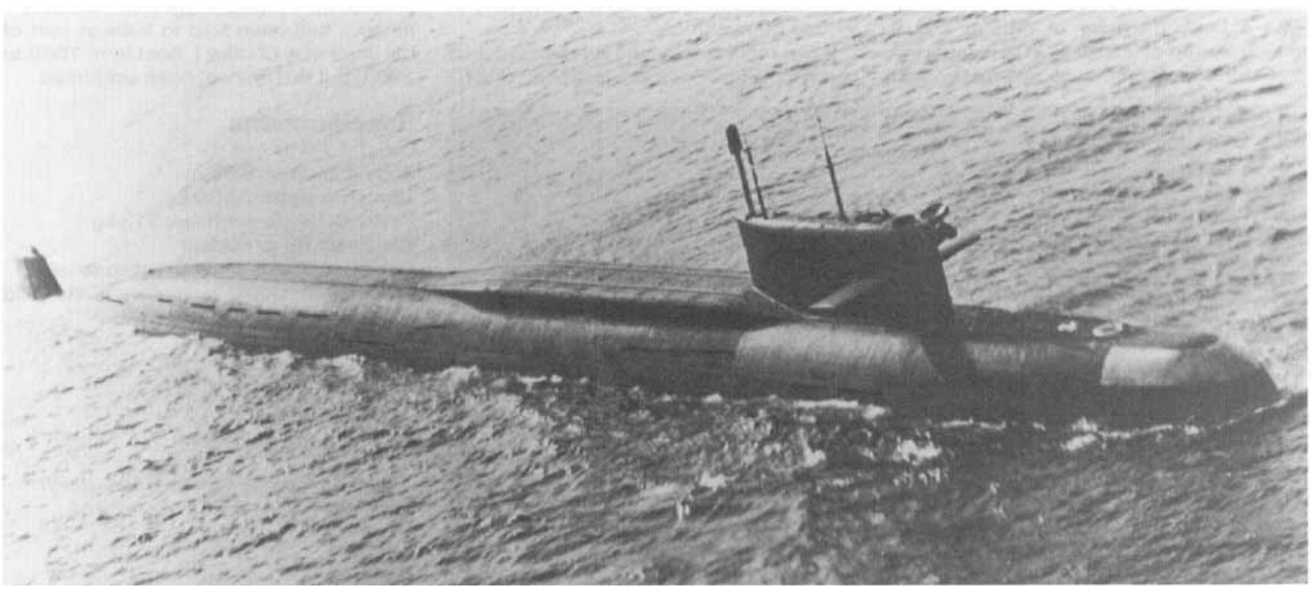
As with the SS-N-5 and SS-N-6, the intermediate-range SS-N-17 was unaffected by the terms of the 1987 INF Treaty, which applied only to land-based missiles. It is reported that Russia withdrew the 'Snipe' from service in 1991 as a result of the START agreement but also due to the high cost involved in a limited deployment.

Specifications

Length: 11.99 m
Body diameter: 1.72 m
Launch weight: 26,800 kg
Payload: Single RV on a PBV, 450 kg
Warhead: 500 kT nuclear
Guidance: Inertial plus computer-controlled PBV
Propulsion: 2-stage solid propellant plus PBV
Range: 3,900 km
Accuracy: 1,400 m CEP

Contractor

The SS-N-17 was designed by the Makeyev Design Bureau.



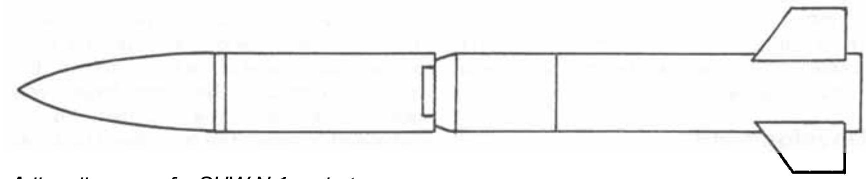
A 'Yankee' class submarine. one of which was modified to carry 12 SS-N-17 Snipe SLBMs

SUW-N-I (FRAS-1) (82R, RPK-1 Vikhr)

Type
Short-range, ship-launched, solid propellant, single warhead, unguided rocket.

Development
SUW-N-1, Free Rocket Anti-Submarine (FRAS-1) was the NATO designation given to the Russian 82R or RPK-1 Vikhr unguided rocket fitted to several larger ASW ships from the late 1960s. Twin launchers were fitted to 'Kiev' class (type 1143) ASW aircraft carriers, and to 'Moskva' (type 1123) ASW cruisers. Little is known of the development of SUW-N-1, except that it was similar to the FROG system, with first flight trials made in 1963 and initial production started from around 1965. There are reports that a Vikhr-M upgrade was developed between 1973 and 1978 with a homing torpedo, but this did not enter service.

Description
It is believed that SUW-N-1 was similar to the US ASROC (RUR-5), and similar in shape to the Russian FROG with four stabilising fins at the rear of the rocket. The rocket length was 6.2 m, with a body diameter of 0.54 m. The launch weight was believed to be 1,500 kg. The rocket had a solid propellant motor, was spin-stabilised, but was unguided. The maximum range was 25 km, and the accuracy at this range was 1,200 m **CEP.** A small nuclear warhead could be fitted, with a yield believed to be around 5 kT, or a unitary high-explosive warhead. The rockets were launched from a twin rail MS-18 launcher, with a 48-round reload magazine below the deck Upon reaching the target area, the warhead depth charge separated from the rocket, and sunk down to 200 m before detonating, with the detonation controlled by either a pressure fuze or a proximity fuze The SUW-N-1 system was controlled by a PUSTB-1123/1143 Sprut fire-control system. An upgraded rocket, designated Vikhr 22, was reported to have been introduced, with a range increased to 45 km.



A line diagram of a SUW-N-1 rocket

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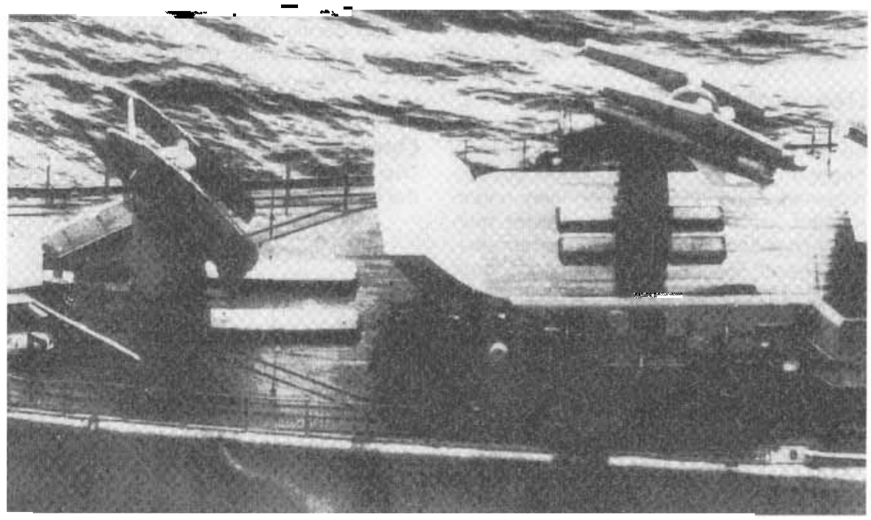
Operational status
SUW-N-1 entered service with the Soviet Navy in 1968. There were no reported exports, but some rockets may have been transferred to the Ukraine. It was believed that around 300 rockets remained in service in 1990, carried by three 'Kiev' class aircraft carriers and two 'Moskva' class cruisers. These rockets were removed from service in 1993.

Specifications
Length: 6.2 m
Body diameter: 0.54 m
Launch weight: 1,500 kg
Payload: Single depth charge
Warhead: HE or 5 kT nuclear
Guidance: Unguided
Propulsion: Solid propellant
Range: 25 km (Vikhr), 45 km (Vikhr 22)
Accuracy: 1,200 m CEP (Vikhr)

Contractor
Developed by NIIG (now Moscow Institute of Thremodynamics) and Novator.



A Moskva class ASW cruiser with a SUW-N-1 twin raillauncher on the left and a twin SA-N-3 'Goblet'launcher on the right (US Navy)

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SSC-2b 'Samlet' (S-2 Sopka/4K87)

Type

Short-range, ground-launched, turbojet-powered, single warhead, surface-to-surface missile.

Development

Initial development of the S-2 Sopka (with the industrial index number 4K87 and the US/NATO designation SSC-2b 'Samlet') coastal defence missile began in 1947. The SSC-2b. and a related air-launched missile the AS-I 'Kennel', were derived from the MiG-15 fighter aircraft, and were developed under the anti-ship missile programme codename Komet. Operational deployment of the SSC-2b variant took place in 1958. In 1960, a mobile Rocket-Assisted Take-Off (RATO) catapult-launched version entered service. The former Soviet Union coastal defence missile battalions known as BROMs *(Beregoviy oborony raketniy batalon)* consisted of three batteries each with six mobile launchers. Each battery was provided with an I-band NATO designated 'Sheet Band' surveillance and fire-control radar located near the launch site.

Description

The SSC-2b 'Samlet' had an airframe derived from the MiG-15 fighter aircraft, but with the cockpit and undercarriage removed. The main body was cigar-shaped, with delta swept-wings at mid-body that had two fences on either side. The aircraft-like tail assembly had a large tailplane mounted in the top half of the vertical fin. There was also a radome protruding above the nose-mounted turbojet inlet. The missile was 7.9 m long, had a maximum body diameter of 1.2 m, a wing span of 4.9 m, and a launch weight of about 3,100 kg. Guidance in the initial stages was by radar beam riding with radio commands to provide mid-course updates. The terminal phase guidance used a semi-active radar seeker, which guided the missile to impact. The ship target was illuminated by the 'Sheet Band' surveillance radar. The propulsion unit was a MiG-15 RD-500K turbojet, which was mounted axially in the missile with straight through ducting.

Initial launch and acceleration was achieved by the jettisonable RATO motor pack fixed immediately beneath the tail jet pipe. After the RATO pack was jettisoned, the turbojet was air started and the missile climbed to its cruising altitude of 300 to 400 m and a speed of M0.8. The missile with its 600 kg HE warhead payload had a maximum effective range of approximately 90 km.

The launch platform was a four-wheeled two-axle trailer with a short launch rail assembly, that had elevation with limited traverse controls. The towing vehicle normally used was a ZII-157V (6 x 6) 2,500 kg tractor truck for semi-trailers. Stored missile life was thought to be five years with annual maintenance checks. After that it had to be completely refurbished.

Operational status

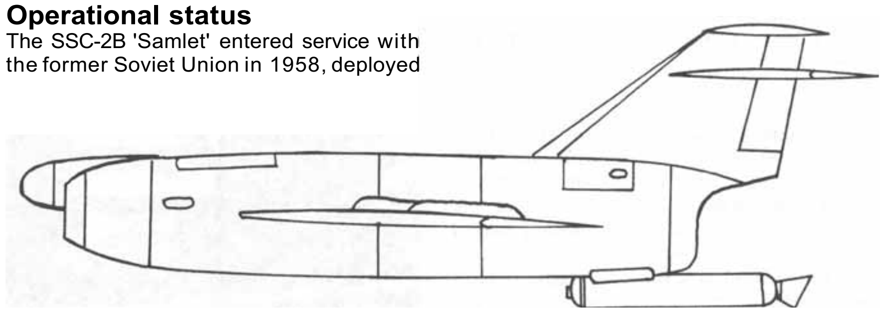
The SSC-2B 'Samlet' entered service with the former Soviet Union in 1958, deployed at Balalava and Kildin Island. It was later exported to Bulgaria, China, Cuba, the former East Germany, Egypt, North Korea and Poland. In 1990 it was reported that only Bulgaria, North Korea and Poland still retained the weapon and that Cuba may have retained some as a war reserve weapon. The only recorded use of the SSC-2b 'Samlet' missile in combat is by Egypt, which fired four against Israeli naval targets during the 1973 Yom Kippur War; apparently all the missiles missed their targets.

Specifications

Length: 7.9 m
Body diameter: 1.2 m
Launch weight: 3,100 kg
Payload: Single warhead 600 kg
Warhead: HE
Guidance: Radio command and semi-active radar
Propulsion: Turbojet
Range: 90 km
Accuracy: n/k

Contractor

Mikoyan-Gurevich design bureau.



Outline diagram of an SSC-2b Samlet' coastal defence surface-to-surface missile

SSC-X-4 'Slingshot' (RK-55 Granat)

Type

Intermediate-range, road mobile, turbofan-powered, single warhead cruise missile.

Development

SSC-X-4 'Slingshot' was one of a family of three cruise missiles developed in the 1970s and early 1980s; the air-launched AS-15 'Kent', the submarine-launched SS-N-21 'Sampson' and the ground-launched SSC-X-4. Designated RK-55 (3K10) and named Granat by the Russians, the missiles were designed for carriage on an eight-wheeled Transporter-Erector-Launcher (TEL) vehicle, with six missiles, carried in launch canisters, per vehicle. The TEL were based upon the SS-1 'Scud B' MAZ 543 TEL design.

Description

The SSC-X-4 missile was 8.09 m long, had a body diameter of 0.51 m and a wing span of about 3.3 m. The launch weight was 1,700 kg, and a single 200 kT nuclear warhead was fitted. Guidance was inertial for mid-course, with some form of terrain matching for position updates and terminal guidance. The missile had a radar altimeter and flew at low level, probably around 200 m. A tandem-mounted solid propellant boost motor was used for launching, but was jettisoned after launch. The turbofan engine was stowed in the rear body of the missile and was lowered into the airstream after launch. SSC-X-4 is reported to have had a maximum range of 3,000 km.

Operational status

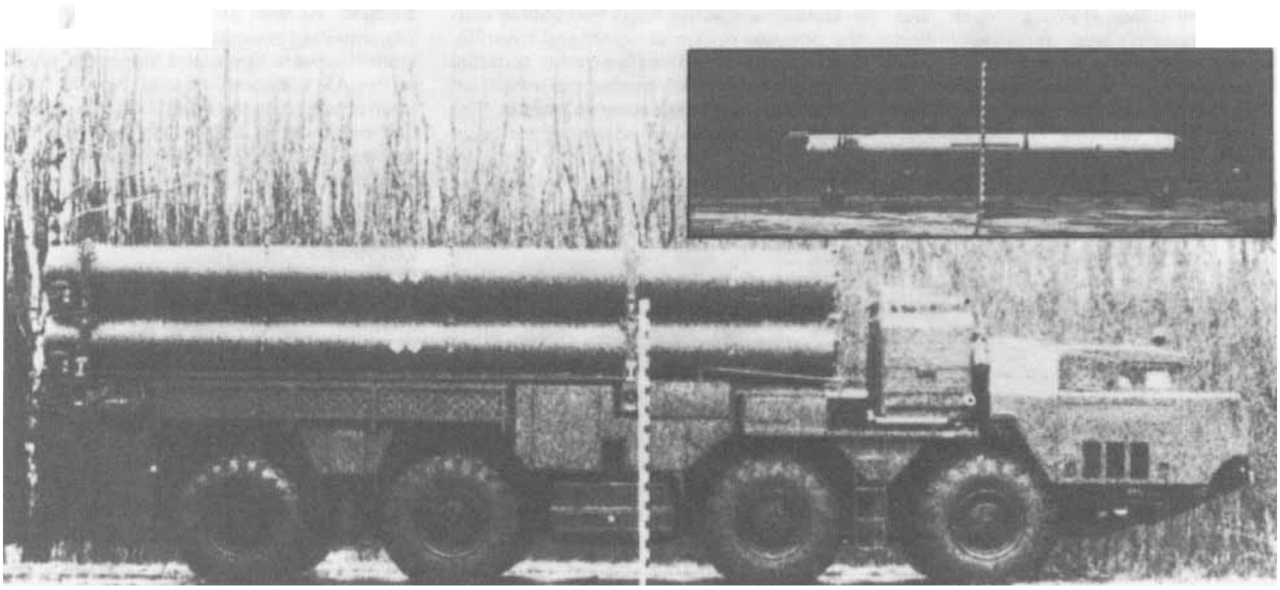
The 1987 INF Treaty banned intermediate-range ground-launched cruise missiles, and the Russians had to destroy their stocks within three years. At the time of data transfer for the INF Treaty, there were 80 missiles and six TEL vehicles, but the missiles were not in operational use and had all been destroyed by June 1989.

Specifications

Length: 8.09 m
Body diameter: 0.51 m
Launch weight: 1,700 kg
Payload: Single warhead
Warhead: 200 kT nuclear
Guidance: Inertial with terrain matching
Propulsion: Turbofan
Range: 3,000 km
Accuracy: n/k

Contractor

Believed to be Raduga NPO.



SSC-X-4 GLCM canisters mounted on their TEL, with a missile inset at top right

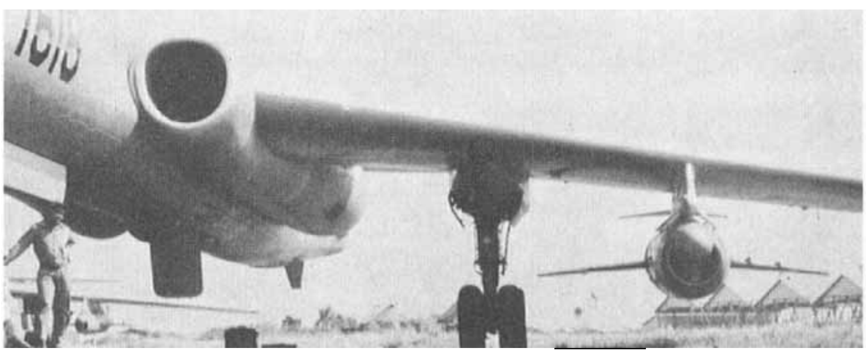
AS-I 'Kennal' (IS-1)

Type
Short-range, air-launched, turbojet-powered, single warhead air-to-surface missile.

Development
Initial development of the KS-1 missile, known in the West under its NATO designation AS-I 'Kennal' started in 1948. This subsonic weapon was the first air-launched cruise missile to be developed by the former Soviet Union and was designed by OKB-155, the design bureau headed by A I Mikoyan and M I Guryevich, and it resembled a scaled-down version of the early MiG fighters. A coastal defence variant, the S-2 'Sopka', with the US/NATO designation SSC-2b 'Samlet' was developed in parallel (for details see separate entry) under the programme code-named Komet. The AS-I was primarily designed for use against medium to large surface ships and was fitted with a semi-active homing radar. The guidance system was reportedly first tested on a MiG-9L dropped from a Tu-4 'Bull' aircraft. Operational deployment of the AS-I is believed to have started in the mid-1950s on the Tu-I6 'Badger' aircraft, which carried one missile under each wing.

Description
The AS-I 'Kennal' had an airframe reported to have been derived from the MiG-15 'Fagot' fighter aircraft. The main body was cigar-shaped with delta swept-wings at mid-body that had two anti-stall fences on either side. The aircraft-like tail assembly consisted of a large swept tailplane mounted high in the swept vertical fin, which had an aerodynamic shaped pod on its tip. This pod, which had a rearward looking antenna, is believed to have contained the electronics for the radio-command system. There was also a distinctive large radome, protruding above the nose-mounted turbojet inlet. The production missile was 8.25 m long, had a maximum body diameter of 1.2 m, a wing span of 4.9 m and a launch weight of about 3,000 kg.

Guidance was inertial in mid-course with the possible option of command override, followed by a semi-active radar terminal homing phase which guided the missile on a pursuit course trajectory to impact. The armour-piercing warhead was reported to have weighed around 600 kg. The propulsion unit was a MiG-15 RD-500K turbojet that was mounted axially in the missile with straight through ducting. This gave the missile a cruise speed of 800 km/h and a range of about 150 km. The missile formed part of the Tu-16KS 'Badger' weapon system known as the *kompleks* K87. During an attack, once in range the AS-I would have been launched in the known direction of targets, and then cruised on autopilot (with possible updates) until its nose-mounted radar detected a sufficiently reflective target. At this point the guidance system switched to its homing mode of operation and the missile went into a diving trajectory towards the target.


An AS-1 'Kennal' anti-shipping missile fitted to the underwing pylon of a Tu-16 Badger' bomber of the Indonesian Air Force

Operational status
The AS-I 'Kennal' entered service with the former Soviet Union Naval Air Service around 1955 for carriage on the Tu-I6 'Badger'. As well as being used by most Warsaw Pact countries, two known export countries were Egypt and Indonesia. Most of the AS-I 'Kennal' missiles would have been replaced by the AS-5 'Kelt' which was first deployed in 1966. It is believed that the last AS-I missiles were taken out of service in 1969.

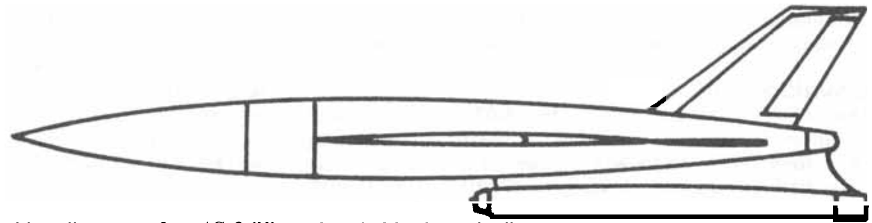
Specifications
Length: 8.25 m
Body diameter: 1.2 m
Launch weight: 3,000 kg
Payload: Single warhead; 600 kg
Warhead: HE armour-piercing
Guidance: Inertial/command and semi-active radar
Propulsion: Turbojet
Range: 150 km
Accuracy: n/k

Contractor
OKB-155, Mikoyan-Guryevich design bureau.

AS-2 'Kipper' (K-1OS)

Type
Short-range, air-launched, turbojet-powered, single warhead air-to-surface missile.

Development
AS-2 'Kipper' is the NATO designation given to a large cruise missile that was reminiscent of the contemporary USAF Hound Dog. The missile, designated K-1*OS* by the Russians, was first observed at the 1961 Soviet Aviation Day fly-by. A single AS-2 was mounted under the fuselage, recessed into the weapon bay of a Tu-16 'Badger-C' aircraft. The AS-2 was developed during the 1950s by the former aircraft-design collective of S A Lavochkin, and formed part of the *kompleks* RSL-1 weapon system. The missile was primarily designed for use against medium to large surface ships and could be fitted with either a large conventional armour-piercing high-explosive warhead or a nuclear warhead with a yield believed to be 500 kT. The AS-2 missile was only cleared for carriage on the Tu-16 'Badger' aircraft.



Line diagram of an AS-2 'Kipper' anti-shipping missile

Description
The AS-2 'Kipper' was a streamlined, long slender missile with an aircraft arrangement of the aerodynamic surfaces. It had a swept-wing midbody and swept vertical and horizontal surfaces at the tail. Under the rear half of the fuselage was a turbojet engine on a short pylon. The missile was 10.0 m long, had a body diameter of 0.9 m, a wing span of 4.9 m and a launch weight of 4,200 kg. Guidance was inertial mid-course with the option of command override, followed by an active radar terminal homing phase. The missile payload could consist of either a 500 kT nuclear or 1,000 kg HE armour-piercing type warhead. The propulsion unit was believed to be the Lyul'ka AI-5 turbojet supplied by 1,000 kg of fuel.

After launch, the missile turbojet would have been air started, and guided to the vicinity of the target by its preprogrammed autopilot, possibly working in conjunction with a radio altimeter and radio-command updates.

When within range, the active radar would be switched on, and then search for, acquire, and home on to the target. The cruise portion of the flight was at high altitude to save fuel, with a speed of M0.9 and a range of 250 km. At a distance appropriate to the target's radar range, the missile would have dived to a low altitude to conduct the final attack at speeds up to M2.0.

Operational status
The AS-2 'Kipper' is believed to have entered service in the late 1950s for carriage on the Tu-16 'Badger C'. The weapon is thought to have been phased out of service with the advent of the AS-4 'Kitchen' and AS-6 'Kingfish', missiles in the mid- to late 1960s. Apart from former Warsaw Pact countries there were no known exports.

Specifications
Length: 10.0 m
Body diameter: 0.9 m
Launch weight: 4,200 kg
Payload: Single warhead: 1,000 kg
Warhead: Nuclear or HE
Guidance: Inertial/command and active radar
Propulsion: Turbojet
Range: 250 km
Accuracy: n/k

Contractor
AS-2 was developed by the S A Lavochkin design bureau.

AS-3 'Kangaroo' (Kh-20)

Type
Short-range, air-launched, turbojet-powered, single warhead cruise missile.

Development
The AS-3 'Kangaroo' was the NATO designation for this nuclear missile developed in the 1950s and is believed to have had the Russian designator Kh-20. This missile appears to have been designed as a land or sea area target weapon, and in today's technology would have been classed as an air-launched cruise missile. It has only been seen carried by the Tu-95K 'Bear B' bomber.

Description
The AS-3 'Kangaroo' was described as a modified Su-7 'Fitter' drone and had two swept-wings at mid-body and an aircraft type tailplane and fin at the rear. A nose intake, with jettisonable cover, provided air for the turbojet engine. The missile was 14.95 m long, had a body diameter of 1.85 m and a wing span of 9.15 m. The missile weighed 11,000 kg. The payload weight was 2,300 kg and contained a single 800 kT yield nuclear weapon. Guidance was inertial with command updates. There was no separate terminal phase guidance system. AS-3 is believed to have had a maximum range of 650 km when released at high level.

Operational status
The AS-3 'Kangaroo' entered service in 1959 and in 1991 about 20 missiles were deployed on 15 Tu-95k 'Bear-B' bombers located at Ukrainka in Russia. Following the START 1 and 2 agreements it is believed that the missiles have been taken out of service.

Specifications
Length: 14.95 m
Body diameter: 1.85 m
Launch weight: 11,000 kg
Payload: Single warhead 2,300 kg
Warhead: 800 kT nuclear
Guidance: Inertial with command updates
Propulsion: Turbojet
Range: 650 km
Accuracy: n/k

Contractor
Believed to be Mikoyan design bureau.

Tu-95 'Bear' bomber carrying an AS-3 'Kangaroo' cruise missile

AS-5 'Kelt' (KSR-2/Kh-11)

Type
Short-range, air-launched, liquid propellant, single warhead, air-to-surface missile.

Development
AS-5 'Kelt' was the NATO designation given to this air-launched anti-ship missile which was developed in the early 1960s. Probably developed as a successor to AS-2 'Kipper', it had certain similarities to the AS-I 'Kennal' and SS-N-2 'Styx' missiles. AS-5 'Kelt' was thought to have entered service in 1966, when it first appeared fitted to the Tu-I6 'Badger' bomber and was believed to have the Russian designator KSR-2 and Kh-11.

Description
The general configuration of the missile was that of a small aircraft, it had swept wings at mid-body, with tailplanes and fin aft. Superficially the nose and the under-body fairing appeared to be identical to those of the ship-launched SS-N-2 'Styx', hence the speculation that the same guidance units could be installed. AS-5 was 8.59 m long, had a body diameter of 0.9 m and a wing span of 4.8 m. The missile weighed 3,000 kg at launch and carried a warhead of around 1,000 kg, this was either conventional HE or nuclear (1 MT). Guidance in mid-course was inertial, with homing carried out by an active J-band radar seeker capable of use in the home-on jam mode. It was reported that the missile could be deployed in two different attack modes. The first being a sea-skimming trajectory for the anti-shipping role, for this a radio altimeter probably similar to that used in the 'Styx' missile was incorporated into the control system. The second mode of attack was one with a high-altitude cruise with a steep dive in the terminal phase. There were reports that the passive infrared terminal homing seeker, used in some 'Styx' variants, had also been fitted to 'Kelt'. There were also reports that an anti-radar version was developed, probably using a passive radar seeker similar to that developed for the AS-4 and AS-6 missiles. AS-5 had a maximum range, when released from high level, of 180 km.

Operational status
AS-5 'Kelt' was believed to have entered service around 1966, but to have been withdrawn by 1990. About 25 'Kelts' were used by the Egyptian Air Force in 1973 against Israeli forces, and five are reported to have been successful. It is believed that 12 of these missiles were anti-radar versions of AS-5. There were no other known exports.

Specifications
Length: 8.59 m
Body diameter: 0.9 m
Launch weight: 3,000 kg
Payload: Single warhead; 1,000 kg
Warhead: HE or 1 MT nuclear
Guidance: Inertial and active radar
Propulsion: Liquid propellant
Range: 180 km
Accuracy: n/k

Contractor
Believed to be Raduga NPO.

An AS-5 'Kelt' air-to-surface missile loaded on the wing pylon of an Egyptian Air Force Tu-16 'Badger' aircraft

Blue Steel

Type
Short-range, air-launched, liquid propellant, single warhead, air-to-surface missile.

Development
Studies for the development of an air-launched guided bomb began in the UK as early as 1949. Early experiments had produced the Blue Boar, but its operational limitations had proved so serious that it was abandoned in 1954 after five years research. A requirement was then issued in 1955 for a missile capable of being launched up to 160 km from the target by day or night and in any weather; two years later a contract was awarded to Hawker Siddeley Dynamics (now Matra BAe Dynamics) for what was to become the Blue Steel standoff guided weapon. It was appreciated early in its development that Blue Steel would be limited in its range, and work began planning Blue Steel Mk 2. This was designed to employ ramjet engines with the range increased to 1,600 km. However, there were early reports of a weapon which the USA was developing, the Skybolt air-launched missile, with a range and yield similar to those proposed for Blue Steel Mk 2, and the UK decided to order Skybolt instead. The USA later cancelled Skybolt, and the UK was offered the submarine-launched Polaris missiles as compensation. Early trials of the Blue Steel missile at the Woomera range in Australia were carried out from Valiant and Victor Mk 1 bombers, and although the results were disappointing, preparations went ahead in 1961 to bring the missile into service, including the decision to fit Blue Steel to Vulcan bombers as well. Blue Steel eventually became operational in 1963, carried by Vulcan Mk 2 bombers and later by Victor Mk 2 bombers. In order to maintain its credibility as a deterrent, the V-force decided to modify its tactics from high- to low-level operations. The most difficult problem was the modification of Blue Steel to give it a low-level launch, however these problems were overcome and the modified Blue Steel became available in mid-1964.

Blue Steel fitted to a modified Avro Vulcan Mk 2 bomber

Preload checks being carried out on a Blue Steel air-tosurface nuclear missile

Description
The Blue Steel air-to-surface missile used a canard and delta-wing configuration on a fuselage that had the general appearance of a large bomb with a sharply pointed nose. The wings, which were mounted centrally at the rear of the fuselage, had anhedral on the tips and aileron control surfaces on the inner panels. Also at the rear of the fuselage was a top-mounted fixed tail fin with an inset rudder and a ventral tail fin that folded upwards to port, to provide adequate ground clearance when the missile was loaded in position under the fuselage of the launch aircraft. The missile was 10.67 m long, had a maximum body diameter of 1.28 m and a wing span of 3.96 m. The span of the delta canard foreplanes was 1.98 m. The propulsion unit was a Bristol Siddeley Stentor twin chamber liquid propellant rocket motor that gave the missile a maximum speed of around M1.6 when operating at high altitude. The guidance system was designed so that the launch aircraft and the missile cross-checked the navigational systems until the missile was fired. After that the missile inertial guidance system steered Blue Steel towards the target by operating the canard foreplanes, wing control surfaces and tail rudder. The missile also had the capability to take evasive action by changes of course and altitude. The missile payload was a single nuclear warhead that had a reported yield of 1 MT. When launched in its high-level profile the Blue Steel had a maximum range of around 300 km.

Operational status
The initial Blue Steel missile entered service in 1963 and the improved low-level version in 1964. By the end of that year a total of 36 bombers were equipped to carry Blue Steel, 24 Vulcans and 12 Victors . It is reported that 23 missiles were used for trials, and that a further 57 missiles entered service. Blue Steel was phased out of service between 1968 and 1970.

Specifications
Length: 10.67 m
Body diameter: 1.28 m
Launch weight: n/k
Payload: Single warhead
Warhead: 1 MT nuclear
Guidance: Inertial
Propulsion: Liquid propellant
Range: 300 km
Accuracy: n/k

Contractor
The prime contractor for Blue Steel was Hawker Siddeley Dynamics (now Matra BAe Dynamics), Stevenage, Herts.

MGR-1 Honest John (M31/M190)

Type
Short-range, road mobile, solid propellant, single warhead unguided rocket.

Development
Development of the Honest John rocket was started by Douglas Aircraft in mid-I950, under the technical supervision of the US Ordnance Missile Laboratories at Redstone Arsenal. Studies had began when the US Army requested a new weapon that had both nuclear and conventional capability, and was designed to be fired as conventional artillery in battlefield areas. Firing tests were completed in 1951 at White Sands, New Mexico and the M31 rocket, now designated MGR-1A, entered service with a conventional HE warhead in 1954. Development of the nuclear warhead for use with the MGR-1 began in 1954, and this was designated W-31. The W-31 warhead was also used for the nuclear version of the MIM-14 Nike Hercules surface-to-air missile. The improved version, designated MGR-1B, with slightly smaller airframe and increased performance, followed the MGR-1A into production to meet US Army and NATO requirements. This version became operational in 1960. It was reported that the US Army carried out testing of semi-active laser guidance kits to enable the missile to home onto its target, but no other details are available. The M190 version rocket had a bulbous warhead containing M139 chemical submunitions.

An MGR-1 Honest John rocket on its launch vehicle (Duncan Lennox)

Specifications

	MGR-1A	MGR-1B
Length	8.31 m	7.92 m
Body diameter	0.76 m	0.76 m
Launch weight	2,640 kg	2,140 kg
Payload	Single warhead; 680 kg	Single warhead; 560 or 680 kg
Warhead	Conventional HE or W-31	Chemical submunitions, unitary HE or W-31
	2, 20, or 40 kT nuclear	2, 20, or 40 kT nuclear
Guidance	Unguided	Unguided
Propulsion	Solid propellant	Solid propellant
Range	32 km	38 km
Accuracy	n/k	1,800 m CEP

Description
The Honest John missile was a surface-to-surface unguided rocket, with two versions being produced. the MGR-1A and the MGR-1B. The missile had a distinctive bulbous nose housing the warhead. Both versions were similar in appearance but differed in length, weight and performance. The MGR-1A was 8.31 m long, had a body diameter of 0.76 m and weighed 2,640 kg at launch. The MGR-1B with its improved booster motor was 7.92 m long, had a body diameter of 0.76 m and weighed 2,140 kg at launch. Both versions used a single-stage Hercules solid propellant boost motor; although unguided they were spin-stabilised by four cruciform fixed tail fins of clipped delta shape which were canted to maintain spin throughout flight. The rocket spin was initiated by two pairs of Thiokol spin rockets aft of the warhead section which were automatically ignited as the rocket left the launcher. The 680 kg warhead was either conventional HE or a W-31 nuclear warhead. The W-31 nuclear warhead had a selectable 2, 20 and 40 kT yield, and used a mechanical combination lock PAL. The warhead could be fuzed for air or surface burst, with selectable height of burst up to 2,000 m altitude. The M190 version carried 368 M139 chemical submunitions in a redesigned warhead assembly weighing 560 kg. The bulbous shaped warhead had four detonation chords, which were initiated by a M421 nose mounted fuze. Following the break-up of the warhead the spherical submunitions would disperse in the air, and would then be opened by a small explosive charge inside each submunition. Each submunition contained around 0.5 kg of chemical agent, and the complete warhead was designed to cover an area of 1 km^2.

The rocket could be launched from a M386 self-propelled truck launcher, M289 self-propelled launcher or M33 towed launcher. The Honest John was aimed at the target and fired on a ballistic trajectory unguided with the launcher elevation determining the range. Maximum range for the MGR-1A was 32 km and for the MGR-1B 38 km. Both variants had the same minimum range of 7.5 km.

Operational status
The MGR-1A Honest John in its conventional role entered operational service with the US Army in 1954 and was deployed in Belgium, Denmark, France, Germany, Greece, Italy, South Korea, Netherlands, Taiwan and Turkey. Deployment of the W-31 nuclear warhead for use with the Honest John rocket began in 1959, and about 1,650 W-31s warheads were produced for use with Honest John. The improved version MGR-1B entered service in 1960. The rocket began to be replaced by the MGM-52 Lance surface-to-surface guided missile in 1972. The last active US Honest John battalion in South Korea retired in 1979 with missiles and equipment turned over to South Korean forces. In 1983 about 200 nuclear versions were still deployed in Greece and Turkey. It is believed that the last Honest John W-31 nuclear warheads were removed from service in mid-I987.

Contractor
The prime contractor for the Honest John programme was Douglas Aircraft.

SSM-A-I 4 Redstone

Type
Short-range, road mobile, liquid propellant, single warhead ballistic missile.

Development
Development of the Redstone short-range ballistic missile began in the early 1950s. The missile, designated SSM-A-14, was at the foundation of the US Army's ballistic missile effort following the Second World War and was an evolutionary V-2 design. The SSM-A-14 was developed by the Redstone Arsenal under the guidance of Wernher von Braun and his V-2 missile design team. In 1956 the US Army requested the application of the W-39 nuclear warhead to the Redstone missile. The Redstone missile had an outstanding flight test programme; during the first 15 launches between 1953 and 1956, only one missile failed. By 1958 when the first Redstone was fired at Cape Canaveral by regular US Army troops, the missile system had undergone some 36 flight tests. The missile became fully operational later that year.

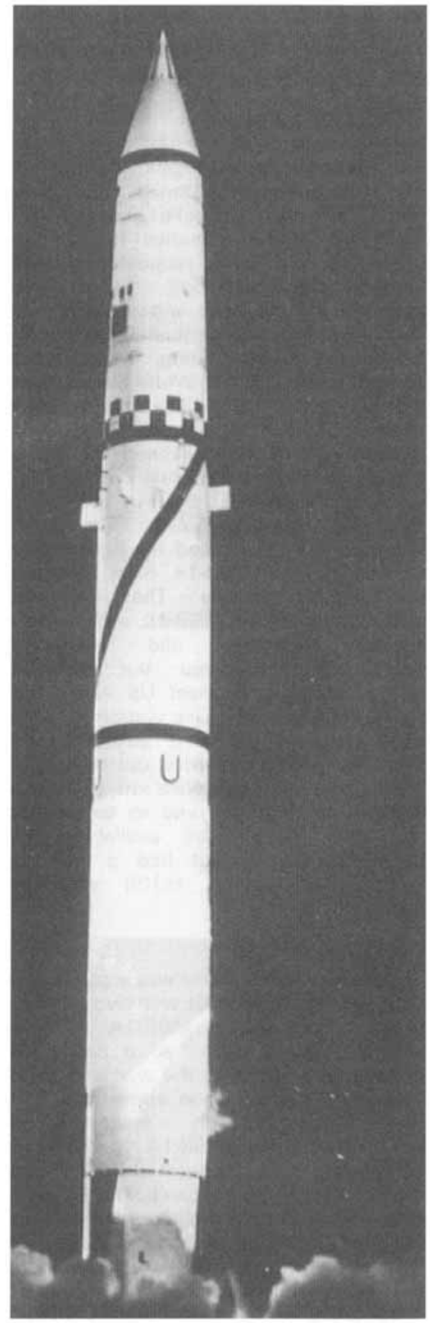
Redstone missiles were used to loft nuclear weapons over Johnston Island for the 'Teak' and 'Orange' shots in 1958 during Operation Hardtack. Modified Redstone missiles were also used as first stage boosters in the Jupiter C vehicles used to put the USA's Explorer satellites in orbit.

Description
The Redstone missile was basically an improved German V-2. The major difference from the V-2 being that the entire liquid propulsion system was jettisoned after burn out, leaving the nose section containing guidance and warhead to continue on a ballistic trajectory towards the target. The propulsion section had cruciform tail fins with movable rudders and refractory carbon vanes operating in the motor exhaust. The nose section consisted of two parts; the front warhead section with a sharp pointed nose and the guidance section that had four small rectangular movable control fins in a cruciform configuration at the rear. The Redstone missile was 21.13 m long, had a body diameter of 1.77 m, a rear fin span of 3.89 m and weighed 27,660 kg at launch. Guidance was by an inertial system developed by Ford Instrument Company. The flight path was fed into the missile by tape before launching and play back signals activated the guidance system during the initial boost phase of flight, keeping the missile on a pre-computed course. The propulsion unit was a North American Rocketdyne A-7 liquid propellant (liquid oxygen and alcohol) motor giving 35,375 kg st. The warhead section was 5.00 m long, had a body base diameter of 1.77 m and weighed 3,580 kg. The missile's nuclear warhead was the W-39, which could be either the W-39 Y1 with a yield of 1 MT, or the W-39 Y2 with a yield of 2 MT. It has also been reported that a conventional HE warhead was available if required. The missile had a maximum range of about 400 km.

Operational status
Redstone entered operational service with the US Army in 1959 and approximately 60 were deployed in NATO Europe with W-39 nuclear warheads. All were retired from service by 1965 when the Redstone was withdrawn from service in favour of the Pershing missile.

Specifications
Length: 21.13 m
Body diameter: 1.77 m
Launch weight: 27,660 kg
Payload: Single warhead; 3,580 kg
Warhead: HE or W-39 1 MT or 2 MT nuclear
Guidance: Inertial
Propulsion: Liquid single-stage
Range: 400 km
Accuracy: n/k

Contractor
The prime contractor for Redstone was the Chrysler Corporation, Michigan.



The launch of a Redstone SSM-A-14 ballistic missile. Note the four small rectangular control fins at the base of the long nose section

SM-75 Thor

Type

Intermediate-range, silo-based, liquid propellant, single warhead ballistic missile.

Development

Development of the Thor missile, designated SM-75, took place in the 1950s at the same time as the Atlas, Minuteman and Titan programmes. The Thor liquid propellant motor was adapted from the Redstone programme. The first four launchings were unsuccessful, but the fifth, in September 1957, produced a flight of 2,170 km. The eighth test missile far exceeded its designed performance by flying 4,587 km and the missile was ordered into production. The warhead developed for the Thor missile was the same as for the Atlas ICBM programme. Originally this was the W-35, but that programme was cancelled and replaced by the W-49 in 1958. The RV used to carry the W-49 warhead was the Mk 2, which was the first USAF heat-sink RV to enter operational service. The Thor missile entered service in 1958 as the USA's first IRBM. Because of its 2,700 km operational range the Thor missile was well suited for deployment in Europe to counter Russian advances in missile technology, but of inadequate range to be fired from bases in the USA against targets in the former Soviet Union. After some months of negotiation, the agreement reached in 1958 provided for the Thor to be manned and operated by RAF units within the UK, the warheads to be kept in US custody and launching to take place only after a joint positive decision by both governments. Test flights were carried out by RAF crews at Vandenberg AFB in California in 1959, and the missile was deployed to the UK that year. The 100th Thor launching was made on 4 October 1960, when a Thor-AbleStar vehicle was used to establish the Courier 1B satellite in orbit. Of the 100 launchings, 73 were successful, 13 partially successful and 14 unsuccessful. The Thor missile was also used extensively during the Dominic nuclear test programmes for Out-of-the-Atmosphere Testing in the early 1960s. A version of Thor was also tested as an ASAT.

After Thor was withdrawn from service in 1963 the manufacturer, Douglas (now McDonnell Douglas) continued production and development of Thor for combat training launchings and for use as first-stage boosters for space vehicles. One of the major new developments was Thrust Augmented Thor (TAT). This involved supplementing the standard Thor booster with three solid propellant Thiokol TX33-52 motors attached externally to the lower part of Thor's body. Some of these space programmes were known as Thor-Able Star, Thor Agena, TAT Agena and Delta.

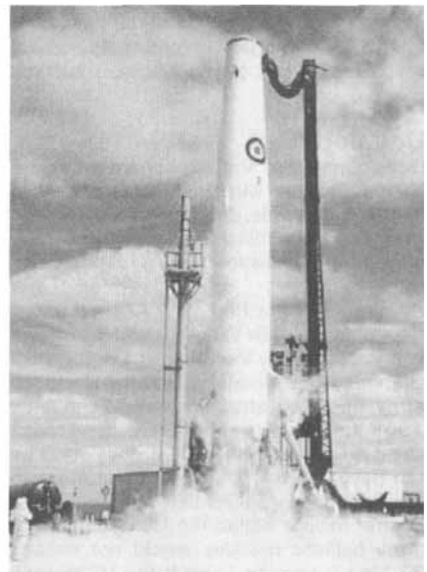
Description

The Thor IRBM was a single-stage missile unusual in appearance, in that the upper half of the body had a straight taper to the blunt end of the Re-entry Vehicle (RV) and there were no tail control surfaces.

The main body was constructed of lightweight aluminium that was integrally stiffened and provided the integral tankage for the liquid oxygen and kerosene propellants. The operational Thor missile was 19.81 m long and had a maximum body diameter of 2.44 m. Its launch weight was 49,900 kg of which 44,680 kg was the weight of the propellants. The Mk 2 RV was 1.50 m long, 1.55 m in diameter and weighed 544 kg. The Thor missile used a North American Rocketdyne MB-3-III liquid propellant motor. Unlike earlier missiles that used exhaust vanes to steer, Thor employed gimbal-mounted motor exhausts which were commanded by the missile's inertial guidance system. On each side of the main engine were liquid propellant vernier rockets that provided speed adjustment after sustainer burn out, as required, plus roll stabilisation. The missile also had small solid propellant retro-rockets, on each side of the centre-body, to retard the airframe after sustainer cut off to ensure separation of the nosecone and RV. The first 1.75 minutes of flight was controlled by a preprogrammed autopilot; then for about one minute the autopilot received instructions from the inertial navigation guidance system, which controlled the flight path until the motors were cut off and RV separation took place. The height and speed at which this occurred was governed by the range of the target from launch point. The missile warhead was the 1.44 MT W-49, which was also used in the Atlas, Titan 1 and Jupiter ballistic missile programmes. Thor was reported to have a maximum range of 2,700 km.

Operational status

Thor entered service with the USAF in 1958. In 1958-59 the USA loaned 60 Thor missiles to the UK in order to supplement



One of the 60 Thor missiles loaned to the UK to supplement its V bomber force in 1960

the RAF's Bomber Command V Force. In 1960 there were 20 missile squadrons with five launch crews to each squadron at dispersed sites, mainly in East Anglia, Lincolnshire and Yorkshire. However, in 1962 the USA decided to concentrate on ICBMs and logistic support was withdrawn from the UK Thor squadrons, and the missiles were returned to the USA. The Thor missiles were retired from active service in 1963-64. A Thor version was used as an ASAT and some missiles were based at Johnson Island in the Pacific from 1964 to 1975 for this role, reported to be able to intercept satellites at up to 1,200 km altitude.

Specifications

Length: 19.81 m
Body diameter: 2.44 m
Launch weight: 49,900 kg
Payload: Single Mk 2 RV
Warhead: W-49 1.44 MT nuclear
Guidance: Inertial
Propulsion: Liquid single-stage
Range: 2,700 km
Accuracy: n/k

Contractor

The prime contractor for the Thor IRBM programme was the Douglas company (now McDonnell Douglas).

SM-78 Jupiter

Type
Intermediate-range, ground-launched, liquid propellant, single warhead ballistic missile.

Development
Development of the Jupiter Intermediate Range Ballistic Missile (IRBM) began in 1954. The missile, designated SM-78, was designed as a follow-on to the Redstone short-range ballistic missile. Jupiter, like the Redstone, was designed and developed at the Redstone Arsenal under the guidance of Dr Wernher von Braun and was produced by the Chrysler Corporation. Originally the missile was to be a mobile army operated strategic weapon, but by 1955 the US administration decided that a sea-going Jupiter should be developed by the navy as well. That programme led to the Polaris missile. As flight testing of the Jupiter missile began the US decided that army ballistic missiles would not exceed 370 km range. As a result the USAF took over the Jupiter project. Under USAF control, all mobility aspects of the missile were removed, and like other USAF missiles of the time, it was adapted for use from above ground launch pads. The warhead chosen for Jupiter was the new W-49 warhead which the USAF also used for their Thor and Atlas missiles. The first full test flight of a Jupiter missile took place in 1957 and achieved the designed range of 2,400 km. Jupiter entered operational service in 1959 when it was deployed to Italy and Turkey.

Modified Jupiter missiles were also used as the first stage of the Juno satellite launch vehicles.

Description
The SM-78 Jupiter was a single-stage, liquid propelled, surface-launched IRBM of constant diameter, with no wings or fins. Like its counterpart, the Redstone missile, the entire liquid propulsion system was jettisoned after burn out, leaving the Re-entry Vehicle (RV) section to continue on a ballistic trajectory towards the target. The RV had the shape of a long triangular cone with a rounded nose. The missile was 18.39 m long, had a body diameter of 2.67 m and weighed 49,885 kg at launch. The Ford Instrument Company guidance system was inertial and controlled the boost stage and the trajectory of the nose section after separation until the RV was ejected. The propulsion unit was a North American Rocketdyne S-3D liquid propellant (liquid oxygen and kerosene) motor giving approximately 68,000 kg st. The exhaust nozzle was gimbal-mounted to provide directional control and stability. The Jupiter warhead unit included a nosecone, the 1.44 MT W-49 nuclear warhead and the power supplies for activating the warhead. The W-49 was equipped with several safety devices to prevent detonation during ground operations and early flight phases. Another safety device prevented explosion over friendly territory. The type of burst, either air or surface, could be selected during a 15 minute countdown before launch. The nosecone was designed to withstand re-entry heat and pressure; ablative layers of glass fibre, plastic and asbestos protected the warhead, arming and fuzing systems. The missile had maximum speed at burn out of M15, the maximum height of trajectory was 660 km, and maximum range was reported to be over 2,400 km with a CEP of 1,800 m.

Operational status
Jupiter entered operational service in 1959 and remained in service until 1965. There were 45 Jupiter missiles deployed in Europe operated by the Italian Air Force (30) and the Turkish Air Force (15).

Specifications
Length: 18.39 m
Body diameter: 2.67 m
Launch weight: 49,885 kg
Payload: Single Mk 3/4 RV
Warhead: W-49 1.44 MT nuclear
Guidance: Inertial
Propulson: Liquid single-stage
Range: 2,400 km
Accuracy: 1,800 m CEP

A ***development*** *SM-78* ***Jupiter at*** *lift off* ***from Cape Canaveral in*** *1958*

Contractor
The prime contractor for Jupiter was the Chrysler Corporation, Michigan.

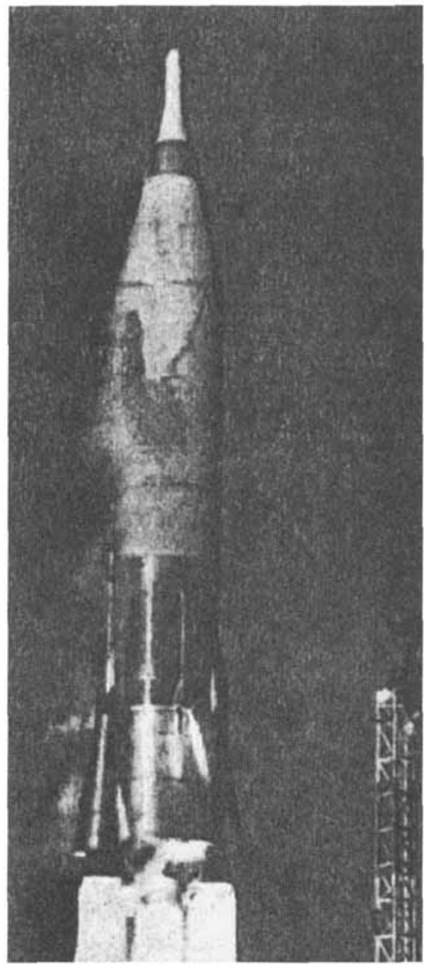
MGM-16 Atlas

Type
Intercontinental-range, ground-launched, liquid propellant, single warhead ballistic missile.

Development
Development of the Convair Atlas intercontinental ballistic missile began in 1945, but the programme was cancelled in 1947 due to restricted funds and low priorities. Although subsequently revived, it was clearly secondary to the USAF's cruise missile programmes. Prior to 1953, the US Air Force favoured the winged cruise missile over the ballistic missile despite studies indicating that the former would be less accurate and reliable, as well as more costly. However, in 1953, it was realised that a megaton class warhead weighing somewhere between 680 kg and 1,360 kg would soon become available, making the ICBM more attractive. The warhead first developed for the Atlas missile was the W-35, but this warhead programme was cancelled in 1958, and was replaced by the W-49 that had a yield of 1.44 MT. Studies conducted in 1953 indicated that Atlas could be operational by 1960, and in 1954, the USAF assigned the highest priority to ballistic missiles. Convair (later General Dynamics) adopted a unique side by side layout for the missile's sustainer and booster engines, which made it possible for all three engines, plus the two small vernier motors, to be fired together at take off. Another feature pioneered with the Atlas was that its external skin was so thin it had to be pressurised during ground transport and as the propellants were burned in flight, in order to preserve its shape. The initial test version, Atlas A, consisted of a booster engine only with a dummy nosecone. Its range was limited to approximately 1,000 km and only 16 were built, eight of which were allocated to flight trials.

The second version, Atlas B, consisted of a complete missile with a sustainer motor and a separate nosecone 10 of which were launched in 1958 and 1959. Atlas C, a semi-operational version which incorporated some advanced features was also tested in late 1958. The first test flight of the initial operational version, Atlas D, with inertial and command guidance failed because of a fault in the propulsion system. However, the second test was successful and the Atlas D with a Mk 2 blunt heat-sink type nosecone and a W-49 nuclear warhead entered operational service in 1959. The type of guidance used in the Atlas D prohibited salvo launching, hence the later version Atlas E and F were fitted with the Bosch-Arma inertial system originally developed for the Titan ICBM. The Titan 1 nuclear warhead W-38 with its higher yield of 3.75 MT was also adapted for use in the Atlas E and F models. These later versions were fitted with the Mk 3 ablative type nosecone. Two other nosecones the Mk 4 and Mk 5 were developed and fitted but no details are available.

Description
The Atlas ICBM had an all-metal pressurised structure, largely of thin gauge stainless steel, forming integral tankage for the liquid propellants. The missile was cylindrical with a constant diameter for about two thirds of its length with a tapered nose that had a re-entry vehicle mounted at the tip. At the base of the missile was a jettisonable flared 'skirt' which helped to provide stability during initial stages of flight. The Atlas D with a Mk 2 re-entry vehicle was 23.11 m long, had a body diameter of 3.05 m and weighed 120,200 kg at launch of which 111,000 kg was propellant. Guidance was inertial and by command, operating in conjunction with a General Electric ground radar and a Burroughs computer. The warhead used in the Atlas D was the 1.44 MT W-49 which was also used in the Thor and Jupiter ballistic missile programmes. The Atlas E and F fitted with a Mk 3 re-entry vehicle were 25.15 m long, had a body diameter of 3.05 m, weighed 122,470 kg at launch, and were fitted with a full inertial guidance system. The warhead used in the Atlas E and F was the 3.75 MT W-38 which was also used in the Titan 1 ICBM. The propulsion system, designated MA2 or MA3, consisted of one Rocketdyne LR 105-3 liquid propelled sustainer, flanked by two Rocketdyne LR89-3 liquid propelled boosters, and two Rocketdyne LR 101-5 vernier rocket motors mounted at 90" to the boosters above the jettisonable flared 'skirt'. All five motors were fired together at launch, and when the boosters jettisoned after burn out, they took with them the flared 'skirt' from around the tail of the missile. The sustainer motor continued to accelerate the missile until it had attained the necessary velocity. The sustainer then shut off and the small vernier rocket motors were used as necessary to trim the missile's velocity and flight path as required. After vernier shutdown the missile followed a ballistic trajectory. The re-entry vehicle, containing the warhead, was separated from the main structure by firing two small retro-rockets after sustainer motor burn out. Atlas was reported to have a burn out speed of about M26 and a maximum range of more than 14,500 km with a CEP of 3,700 m.



The launch of a Convair Atlas D ICBM with a General Electric Mk 3 ablative nosecone

Specifications

	Atlas D	Atlas E/F
Length	23.11 m	25.15 m
Body diameter	3.05 m	3.05 m
Launch weight	120,200 kg	122,470 kg
Payload	Single Mk 3/4 RV	Single Mk 4 RV
Warhead	W-49, 1.44 MT nuclear	W-38, 3.75 MT nuclear
Guidance	Inertial with command update	Inertial
Propulsion	Liquid propellant 2-stage	Liquid propellant 2-stage
Range	14,000 km	14,000 km
Accuracy	n/k	3,700 m CEP

Operational status
The Atlas missile became operational in 1959, and it remained in service until around 1965. At the end of production some 125 missiles of various Mks (Atlas D, E and F) were deployed with 13 SAC missile squadrons at 11 air bases in the USA. Most of these missiles were converted to form the basis of the Atlas SLV-3 space launch vehicles.

Contractor
The Atlas was designed and built by Convair (General Dynamics).

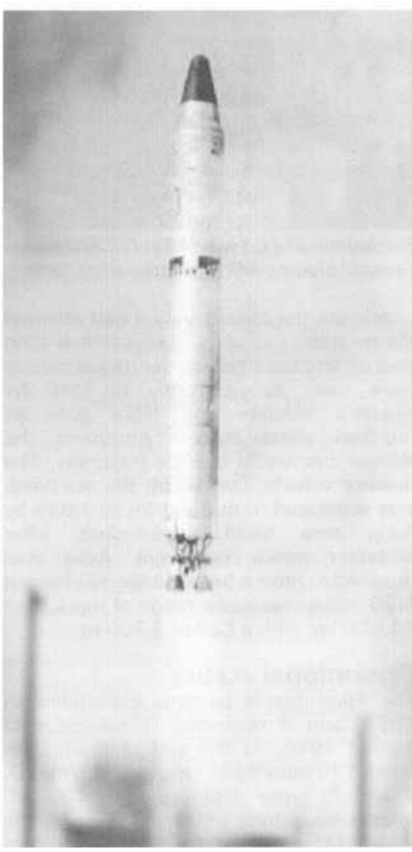
MGM-25A/LGM-25C Titan 1 and 2 (SM-68)

Type

Intercontinental-range, silo-based, liquid propellant, single warhead ballistic missile.

Development

Development of the two-stage MGM-25A Titan 1 missile took place in the mid-to late 1950s at the same time as the Atlas, Minuteman and Thor programmes. The Titan was designed to be operated from hardened silos, with a large single nuclear warhead for use against large undefended soft targets. Titan 1 was first launched in 1959, but by the end of 1960 10 full range flights had been accomplished with all systems functioning and the missile entered service. Development work on the improved LGM-25C Titan 2 began in 1960 and that missile system entered service in 1963. One of the most important improvements in the Titan 2 was that it could be fired from underground within the silo rather than having to be raised to the surface to be fired as in the case of the Titan 1. It is reported that an improved guidance system was developed for Titan 2 in order to increase the missile's accuracy, and this is believed to have been fitted from 1979 onwards. A further development of the Titan ICBM was its use as the USAF launch vehicle for NASA's Gemini two-man spacecraft programme.



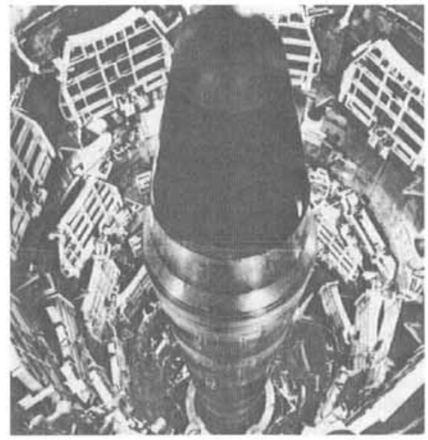
The launch of a Titan 2 missile

Description

The MGM-25A Titan 1 was a two-stage, liquid-propelled, Inter-Continental Ballistic Missile (ICBM) that had a distinctive shape, in that the two stages were of different diameter and the RV was a long slender tube with a rounded end. The two stages were a rigid structure of an aluminium alloy and had no wings or fins. The length of Titan I's first stage was 17.37 m and had a body diameter of 3.05 m, the body diameter of the second stage was 2.44 m. The overall length of the missile was 29.87 m and weighed 99,790 kg at launch. Missile guidance was by an inertial and command system, and flight control was carried out by large gimballed motor exhaust nozzles, two in the first stage and one in the second. The first stage propulsion unit was an Aerojet-General LR-87 liquid propellant motor with two chambers giving a total of 136,000 kg st. The second stage was an Aerojet-General LR-91 single chamber liquid propellant motor giving 36,290 kg st. Both motors used liquid oxygen and kerosene propellants. The warhead used in the Titan 1 was a 3.75 MT W-38 fitted in a Avco RV Mk 4. The missile speed at burn out was approximately M25, this gave Titan 1 a maximum range of 10,000 km and a reported CEP of around 1,400 m.

The LGM-25C Titan 2 was the largest USAF intercontinental ballistic missile fitted with a single high-yield warhead, and was the last liquid fuelled ICBM missile to be used by the USA. The LGM-25C was 31.30 m long and both stages had the same diameter of 3.05 m. The missile weighed 149,700 kg at launch.

Guidance was by an inertial system designed and manufactured by AC Electronics, and flight control was carried out by large gimballed motor exhaust nozzles, two in stage one and one in stage two. The first stage propulsion unit was an uprated Aerojet-General LR-87 liquid propellant motor with two chambers having a total of 195,000 kg st. Second stage was an uprated Aerojet-General LR-91 single chamber liquid propellant motor giving 45,360 kg st. The Titan 2's payload comprised of a single Mk 6 re-entry vehicle with a W-53 nuclear warhead which weighed 4,000 kg and had a yield of 9.0 MT. The Mk 6 RV was fitted with penetration aids. The W-53 warhead was similar to the basic B53 bomb carried by the B52 bombers. The Titan 2 was reported to have had a maximum range of 15,000 km and CEP of 900 m.



An LGM-25C Titan 2 missile in its underground silo

Operational status

Titan 1 entered service in 1961 and was retired in 1965, being replaced by the Titan 2. The LGM-25C Titan 2 entered operational service in 1963. When the retirement programme for the Titan 2 force began in October 1982 there were 49 missiles deployed, 17 at Little Rock AFB, Arkansas, 17 at McConnell AFB, Kansas and 15 at Davis-Monthan AFB, Arizona. The Titan force was completely deactivated by 1987.

Contractor

The prime contractor for the Titan ICBM programme was Martin Marietta, Baltimore, Maryland (now Lockheed Martin).

Specifications

	Titan 1	Titan 2
Length	29.87 m	31.30 m
Body diameter	3.05 m 1st stage 2.44 m 2nd stage	3.05 m both stages
Launch weight	99,790 kg	149,700 kg
Payload	Single W38/Mk 4 RV	Single W53/Mk 6 RV with penetration aids
Warhead	3.75 MT nuclear	9.0 MT nuclear
Guidance	Radio command	Inertial
Propulsion	2-stage liquid	2-stage liquid
Range	10,000 km	15,000 km
Accuracy	1,400 m CEP	900 m CEP

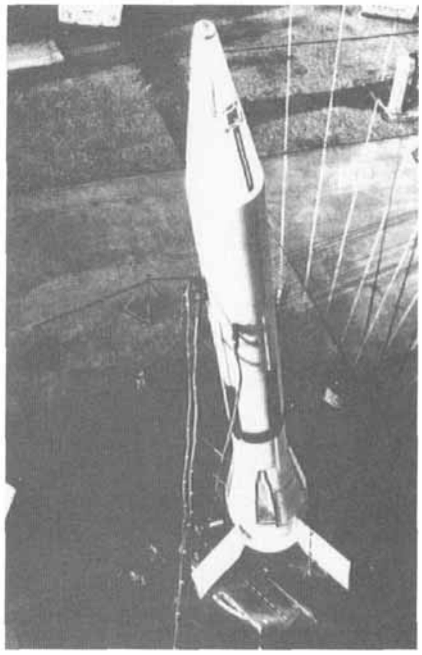
UGM-27 Polaris (A-1/-2/-3)

Type
Intermediate-range, submarine-launched, solid propellant, single and multiple warhead ballistic missile.

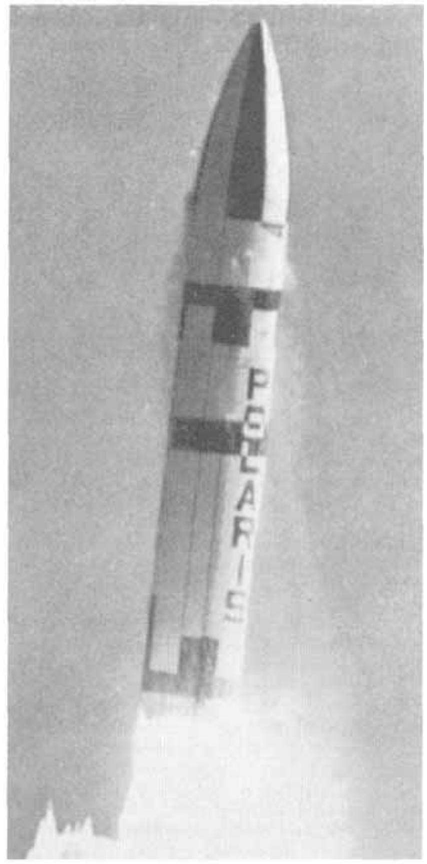
Development
Development of the Polaris Submarine-Launched Ballistic Missile (SLBM) system began in 1956, when Lockheed (now Lockheed Martin) were awarded a contract to determine feasibility of SLBM development. The first test flight of a Polaris missile took place in 1958 and construction started on the first three Polaris submarines. The first full successful flight test of the Polaris A-1 missile took place in 1959, and the first Polaris submarine USS *George Washington* was commissioned later that year. At the same time development of the Polaris A-2 was underway and this version completed its first test flight in 1961. In 1962 the USS *Ethan Allen* successfully fired a Polaris missile with a W-47 nuclear warhead. The Polaris A-3 missile entered its development phase in 1960 and was tested in 1962. Unlike its two predecessors, Polaris A-3 was nearly 85 per cent a new missile. In addition to possessing a greater range and a new improved guidance system, it also had the first operational Multiple Re-entry Vehicle (MRV) with three RVs, designed to increase the lethal blast area and saturate ABM defences. A new 200 kT nuclear warhead, designated W-58, was developed for use in the new MRV. The Polaris missile system went on to be fitted to 30 USN submarines, but these boats were later converted to take the UGM-73 Poseidon C-3 missile. The Polaris A-3 was sold to the UK in the late 1960s and was modified and designated A-3TK Polaris. These missiles were fitted to 4 SSBN of the 'Resolution' class, with each carrying 16 missiles. The UK version had a penetration aid suite known as Chevaline, mounted on a 500 kg penetration aid carrier. The warheads were built in the UK, but are believed to have been similar to the US designed W-58 warheads with a yield of 200 kT each.

Description
The Polaris A-1/A-2 missiles were solid propellant, submarine-launched ballistic missiles that had a constant diameter for the two stages of propulsion, no wings or fins and a fairly long tapered RV which had a rounded nose. This configuration gave both missiles an overall shape of a 'champagne bottle'. Both stages of the Polaris A-1 were made of thin gauge steel. The A-I missiles were 8.53 m long, had a body diameter of 1.37 m and weighed 12,700 kg at launch. The guidance system was inertial and each of the two stages contained an Aerojet-General solid propellant motor with four nozzles and 'jetevators' for missile control.

The RV Mk 1 including the W-47 warhead, weighed 408 kg and was fitted with spin rockets and an arming and fuzing system. The W-47 weighed about 275 kg and the W-47-Y1 fitted to the A-1 missile yielded 600 kT. The range of the A-I was reported to be in the order of 1,800 km and it had a CEP of around 1,800 m. The first stage of the Polaris A-2 was made of thin gauge steel and the second stage glass fibre. The missile was 9.45 m long, had a body diameter of 1.37 and weighed 13,600 kg at launch. The guidance system was inertial. Both stages contained an Aerojet-General solid propellant motor with four nozzles. The first stage used 'jetevators' for missile control similar to the A-I, but the second stage had gimballed nozzles for control. The RV used in the A-2 missile was the same as for the A-I but it carried an updated version of the W-47 warhead the W-47-Y2 or -Y3 which had a yield of 800 kT. The A-2 had a maximum range of 2,400 km and a CEP of 1,200 m. Polaris A-3 had a different nose shape to the earlier A-I and A-2 missiles, like a blunt bullet, and this was to accommodate the MRV. The A-3 missile was 9.55 m long, had a body diameter of 1.37 m and weighed 13,600 kg at launch. The guidance system was an improved version of the inertial system fitted to the A-I and A-2 missiles. Both stages of the A-3 missile had glass fibre casings. The first stage contained an Aerojet-General solid propellant motor with gimballed nozzles, whereas the second stage had a Hercules motor with a thrust vector control system using fluid injection. The 3 RVs carried by the Polaris A-3 were the RV Mk 2, it was 1.37 m long, had a base diameter of 0.60 m, a forward diameter of 0.29 m and weighed 140 kg. Each RV Mk 2 carried a W-58 nuclear warhead with a yield of 200 kT. These warheads had the option of both air and ground burst fuzing systems. The range of the A-3 missile was reported to be in the order of 4,630 km with an accuracy of 900 m CEP.



An early Polaris A-1 missile being prepared for a ground-launched test flight Note missile is not fitted with the usual RV Mk 1



Underwater launch of a Polaris A-3 missile

Operational status
The Polaris A-1 SLBM entered service in 1960, the A-2 variant entered service in late 1961 and went on to be fitted a total of 13 submarines. The last Polaris A-2 patrol took place in June 1974.

Specifications

	Polaris A-1	Polaris A-2	Polaris A-3
Length	8.53 m	9.45 m	9.55 m
Body diameter	1.37 m	1.37 m	1.37 m
Launch weight	12,700 kg	13,600 kg	13,600 kg
Pay load	Single Mk 1 RV	Single Mk 1 RV	3 Mk 2 RV
Warhead	W-47-Y1 600 kT	W-47-Y2/Y3 800 kT	W-58, 200 kT each
Guidance	Inertial	Inertial	Inertial
Propulsion	2-stage solid	2-stage solid	2-stage solid
Range	2,200 km	2,800 km	4,630 km
Accuracy	1,800 m CEP	1,200 m CEP	900 m CEP

The Polaris A-3 entered service in 1964. The conversion of the Polaris submarine fleet to the Poseidon C3 missile began in 1969 and by 1977 a total of about 30 Polaris **SSBNs** had been converted to carry the Poseidon missiles. The last Polaris A-3 patrol is reported to have taken place in 1981. The A-3TK Polaris missile entered service in the UK in 1969 and a total of 133 missiles were ordered. This system was taken out of service in 1996.

Contractor

The prime contractor for the Polaris missile system was the Lockheed Missile and Space Corporation, Sunnyvale, California (now Lockheed Martin).

MGM-29 Sergeant (M-15)

Type

Short-range, road mobile, solid propellant, single warhead ballistic missile.

Development

Development of the Short Range Ballistic Missile (SRBM) Sergeant began in 1953 at the US Army's request for a nuclear replacement for the SSM-A-17 Corporal surface-to-surface weapon. The design called for a missile that was more mobile than Corporal, air transportable and could be emplaced and fired in a few minutes by a six-man crew. By 1955 studies had shown that a nuclear warhead was feasible for the new missile. By the end of 1957, the size of US nuclear weapons had been reduced sufficiently to allow a decision to be made for a new warhead to be developed specifically for the Sergeant, now designated MGM-29. The warhead, which had the designator W-52, was completed in 1961 and the Sergeant missile entered service in 1962.

An MGM-29 Sergeant SRBM deployed in the field and ready for firing

Description

The Sergeant SRBM missile was similar in performance to the USA Honest John and the Russian FROG 7 rockets, but Sergeant was guided and used a solid propellant motor. The missile had an all-metal cylindrical body with a long sharp pointed nosecone. At the tail there were fixed cruiform fins of long cord clipped delta planform. The MGM-29 missile was 10.51 m long, had a body diameter of 0.79 m, a finspan of 1.78 m and a launch weight of 4,580 kg. Guidance and control was by an inertial guidance system developed and manufactured by Sperry, this operated small control surfaces hinged to the trailing-edges of the four fins and linked to jet-deflectors in the motor efflux. The propulsion unit was a 3,200 kg Thiokol M-53 solid propellant motor rated at 22,700 kg st which gave the missile a maximum speed of M3.5 at burn out. The warhead was either conventional HE or nuclear depending on operational requirement. The nuclear warhead developed for Sergeant was the W-52, this had a 60 kT yield and weighed 500 kg. The Sergeant missile was fired from an elevation angle of 75°, had a maximum range of 135 km and a minimum range of 40 km.

Operational status

Sergeant entered operational service with the US Army in 1962 and started replacing US Army Corporal throughout Western Europe in 1963. The missile began being replaced by MGM-52 Lance in 1972 and was finally retired from active service in 1977.

Specifications

Length: 10.51 m
Body diameter: 0.79 m
Launch weight: 4,580 kg
Payload: Single 500 kg warhead
Warhead: HE or W-52 60 kT nuclear
Guidance: Inertial
Propulsion: Solid single-stage
Range: 135 km
Accuracy: n/k

Contractor

The prime contractor for the Sergeant programme was Sperry Rand Company, Utah.

LGM-30A/B Minuteman I (SM-80/HSM-80A)

Type
Intercontinental-range, silo-based, solid propellant, single warhead ballistic missile.

Development
Development of the Minuteman family of ICBM began in the late 1950s and invitations to tender were issued early in 1958. Out of the 14 bids made, that of Boeing was accepted in October of that year. Minuteman was designed as a simplified second generation ICBM to supersede the earlier liquid propellant Atlas and Titan missiles. Its solid propellant motors enabled it to be stored at instant readiness in launch sites. The first Minuteman surface launch took place at Cape Kennedy in 1961. The first silo launch attempted later that year failed, but a second attempt was successful. The production line started in 1962 and the first production missile was assembled at Hill AFB in April 1962. The first 20 Minuteman I missiles were declared operational in December 1962. An improved version, designated LGM-BOB, was developed and became operational in July 1963.

In 1974 the practicability of air launching an ICBM of this type was tested by the USAF. A Minuteman Iwas extracted by parachutes through the open rear door of a C-5A Galaxy transport aircraft; after turning to an upright position and dropping to a height of 2,440 m its motor was ignited successfully for 10 seconds after which the missile was allowed to fall back into the sea.

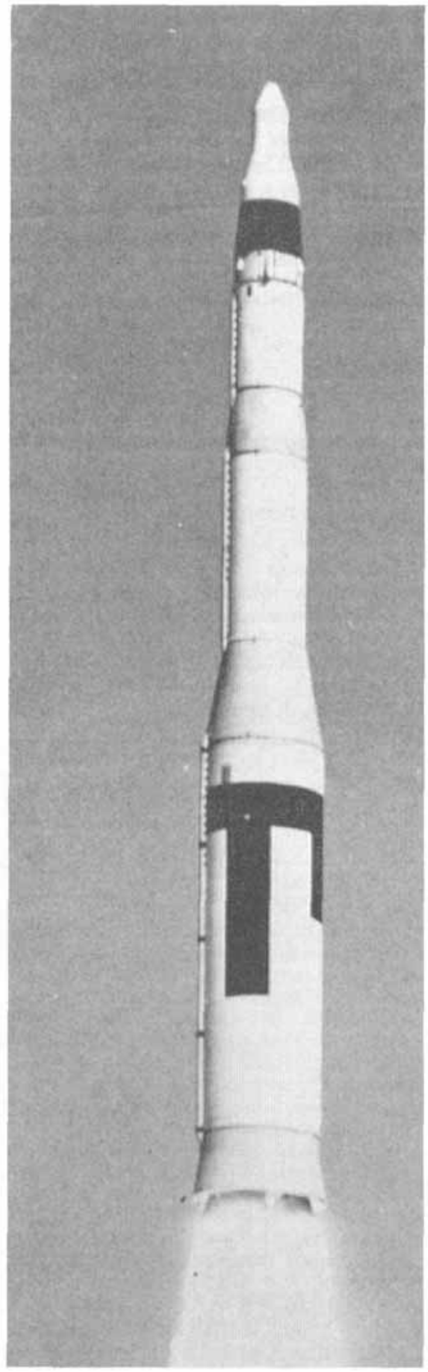
Description
The Minuteman I was a three-stage solid propellant ballistic missile with no wings or fins. The two upper stages had a smaller diameter than the first stage, and the re-entry vehicle had an ogival nose cover. The missile was produced in two versions; the LGM-30A which was 16.45 m long and the LGM-30B that was slightly longer at 17.00 m. Both missiles had the same first-stage base diameter of 1.88 m and weighed around 29,500 kg at launch. Missile guidance was inertial and flight control was carried out by a preprogrammed digital computer. The first-stage engine was produced by Thiokol and exhausted through four swivelling nozzles. The second- and third-stage motors also had four control nozzles, these were produced by Aerojet-General and Hercules respectively. The payload was a single Mk 11 re-entry vehicle with a W-59 nuclear warhead, having a yield of 1.0 MT. The maximum range for the LGM-30A was reported to be 10,000 km, with the LGM-30B being slightly greater.

Operational status
The LGM-30A entered operational service in 1962 at Malmstrom AFB, Montana. The first improved LGM-30B became operational in 1963 at four other bases. By June 1965 all 800 Minuteman I missiles had been delivered to service; Warren AFB, Wyoming was equipped with 200 missiles, while Ellsworth AFB, South Dakota, Minot AFB, North Dakota and Whiteman AFB, Missouri all had 150 missiles each.

The Minuteman I started to be replaced by LGM-30F Minuteman II in 1965, and all had been retired from active service by 1969.

Specifications
Length: 16.45 m, LGM-30A; 17.00 m, LGM-30B
Body diameter: 1.88 m
Launch weight: 29,500 kg
Payload: Single Mk 11 RV
Warhead: 1.0 MT nuclear
Guidance: Inertial
Propulsion: 3-stage solid
Range: 10,000 km
Accuracy: n/k

Contractor
The prime contractor for Minuteman Iwas Boeing Aerospace, Seattle, Washington.



Test flight of an early LGM-30A Minuteman I ICBM

LGM-30F Minuteman II

Type
Inter-continental-range, silo-based, solid propellant, single warhead ballistic missile.

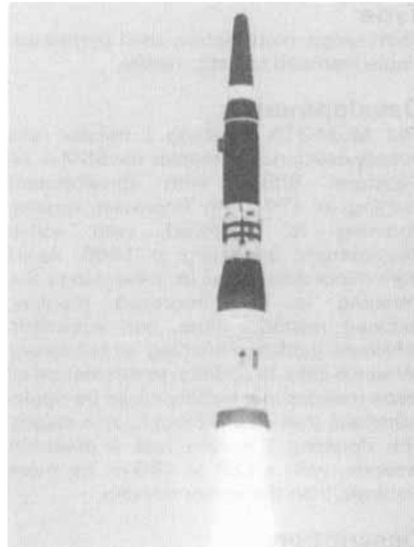
Development
The LGM-30F Minuteman II was essentially an improved version of the Minuteman I rather than being a new missile. Development of Minuteman II began in 1962, just as the Minuteman I missiles entered service. It had increased range and payload and also has improvements in the guidance system, which provided better azimuthal coverage, accuracy and choice of targets. Some of the missiles were fitted with penetration aids, improving capability to penetrate the Moscow defences.

Modernisation in the early 1980s concentrated on the launch facilities and command and control systems, partly to decrease reaction time but primarily to improve survivability under nuclear attack. The last changes to support facilities were made to improve compatibility with the Peacekeeper system requirements, as these latter missiles were introduced into further hardened versions of the Minuteman silos.

Description
The Minuteman II missile was a three-stage solid propellant ballistic missile 18.2 m long and 1.8 m in diameter at its base. Its launch weight was 31,746 kg and it had a range of 12,500 km. The US declared the throw weight as 800 kg in 1991. The payload comprised a single Mk 11C re-entry vehicle with a W56 nuclear warhead, having a yield of 1.2 MT, and some missiles were fitted with penetration aid packages.

Operational status
The Minuteman II Inter-continental Ballistic Missile (ICBM) entered service in 1965, with production completing in 1967. US Department of Defense (DoD) announced in 1990 that Minuteman II would be withdrawn from service from 1992 onwards, at a rate of about 65 missiles per year until 1998. A total of 450 missiles were deployed in 1990, at Malmstrom, Ellsworth and Whiteman AFBs with 150 missile silos located at each site. By mid-1994 all Minuteman II missiles had either been removed from their silos, or had their guidance systems and warheads removed to render them non-operational. The last silo was destroyed in January 1998. Lockheed Martin Astronautics received a contract in 1995 to convert Minuteman missiles for orbital and sub-orbital launches, and in 1996 the US DoD approved a USAF plan to convert up to five Minuteman II missiles for satellite launches. In 1997, Orbital Sciences were awarded a contract to convert 24 missiles for launches between 1999 and 2004. Over 60 second-stage SR-19 motors were modified by Aerojet from 1992 for use as first-stage motors for ballistic missile targets. The liquid injection thrust vector control system of the original SR-19 motor was replaced by a moving nozzle with a hydraulic actuation system.

Specifications
Length: 18.2 m
Base diameter: 1.8 m
Launch weight: 31,746 kg
Payload: Single Mk 11C RV plus penetration aids
Warhead: 1.2 MT nuclear



An LGM-30F Minuteman II at launch
2002/0132982

Guidance: Inertial
Propulsion: 3-stage solid propellant
Range: 12,500 km
Accuracy: 200 m CEP

Contractor
It was not always the practice of the US Air Force to appoint a prime contractor for its weapons systems, the preference being to have major system and integration contractors, with the final responsibilities for the system being taken by the service itself. The primary co-ordinator for the Minuteman II missile system was Boeing Aerospace

MGM-31A Pershing I

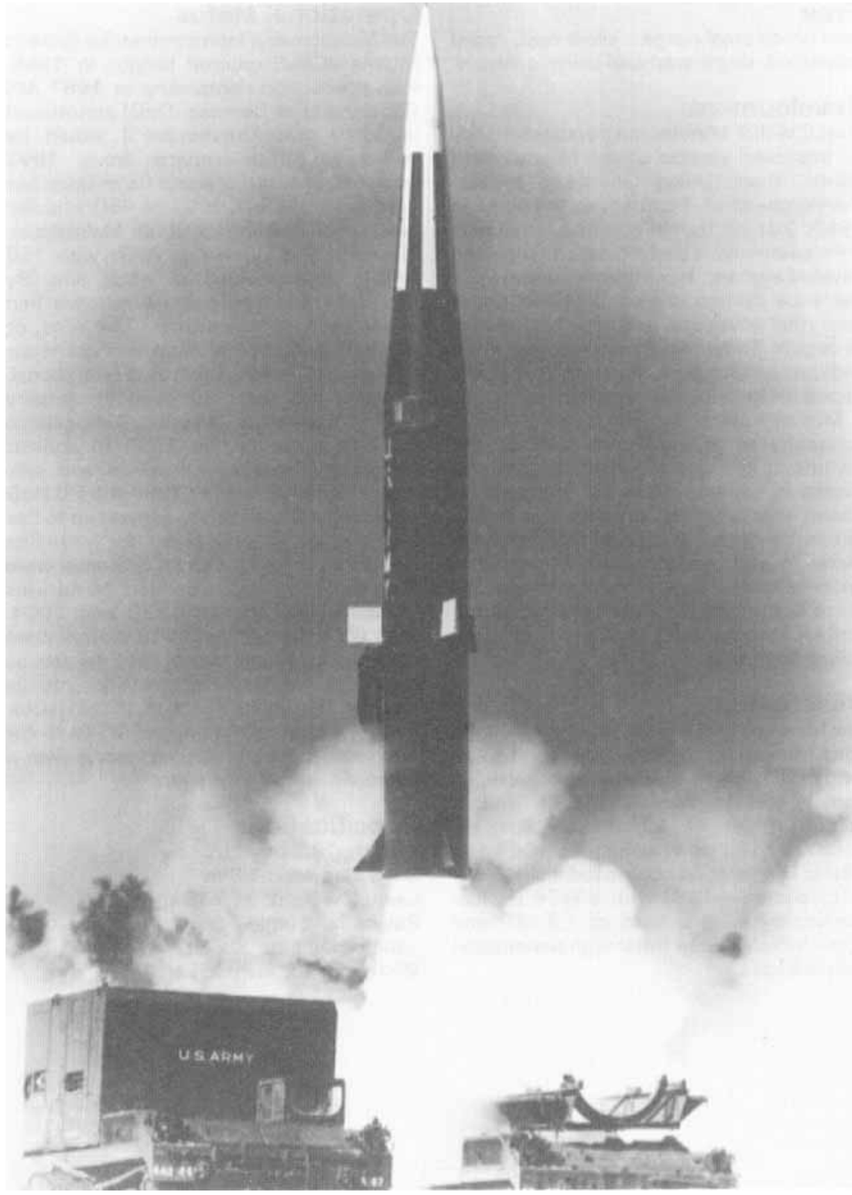
Type
Short-range, road mobile, solid propellant, single warhead ballistic missile.

Development
The MGM-31A Pershing I missile was initially developed to replace the SSM-A-14 Redstone SRBM, with development starting in 1960. An improved version, Pershing Ia, followed with initial development beginning in 1966. Apart from minor differences from Pershing I, the Pershing Ia had improved mobility, reduced response time, and automatic reference guidance needing no pre-survey of launch sites. In addition to this feature all three missiles in a battery could be ripple-launched; that was without launch delays. The Pershing I missile was a precision weapon, with a CEP of 150 m, far more accurate than the earlier missiles.

Description
The Pershing Ia was a short-range ballistic missile 10.55 m long and 1.02 m in diameter, It had a launch weight of 4,600 kg and a range of 740 km. It had a two-stage solid propellant motor and an inertial guidance system. The warhead was a W-50 nuclear, with a yield of 400 kT.

Operational status
The Pershing Ia missile was deployed in NATO Europe, with the US Army and German Air Force, deployment being completed in 1971. The US Army had withdrawn all its Pershing Ia missiles from Europe by 1985 in favour of Pershing II, but the German missiles remained. All versions of Pershing were due for withdrawal and destruction under the terms of the 1987 INF Treaty, which constrains all land-based missiles with ranges over 500 km. All 169 US Pershing Ia missiles had been destroyed by October 1989, and the 72 German missiles by May 1991.

Specifications
Length: 10.55 m
Body diameter: 1.02 m
Launch weight: 4,600 kg
Payload: Single warhead
Warheads: 400 kT nuclear
Guidance: Inertial
Propulsion: 2-stage solid
Range: 740 km
Accuracy: 150 m CEP



A Pershing Ia is launched at Fort Wingate, New Mexico, USA for a trials flight in 1963

Contractor
Martin Marietta Electronics and Missile Group, Orlando, Florida (prime contractor) (now Lockheed Martin).

MGM-31B Pershing II

Type
Intermediate-range, road mobile, solid propellant, single warhead ballistic missile.

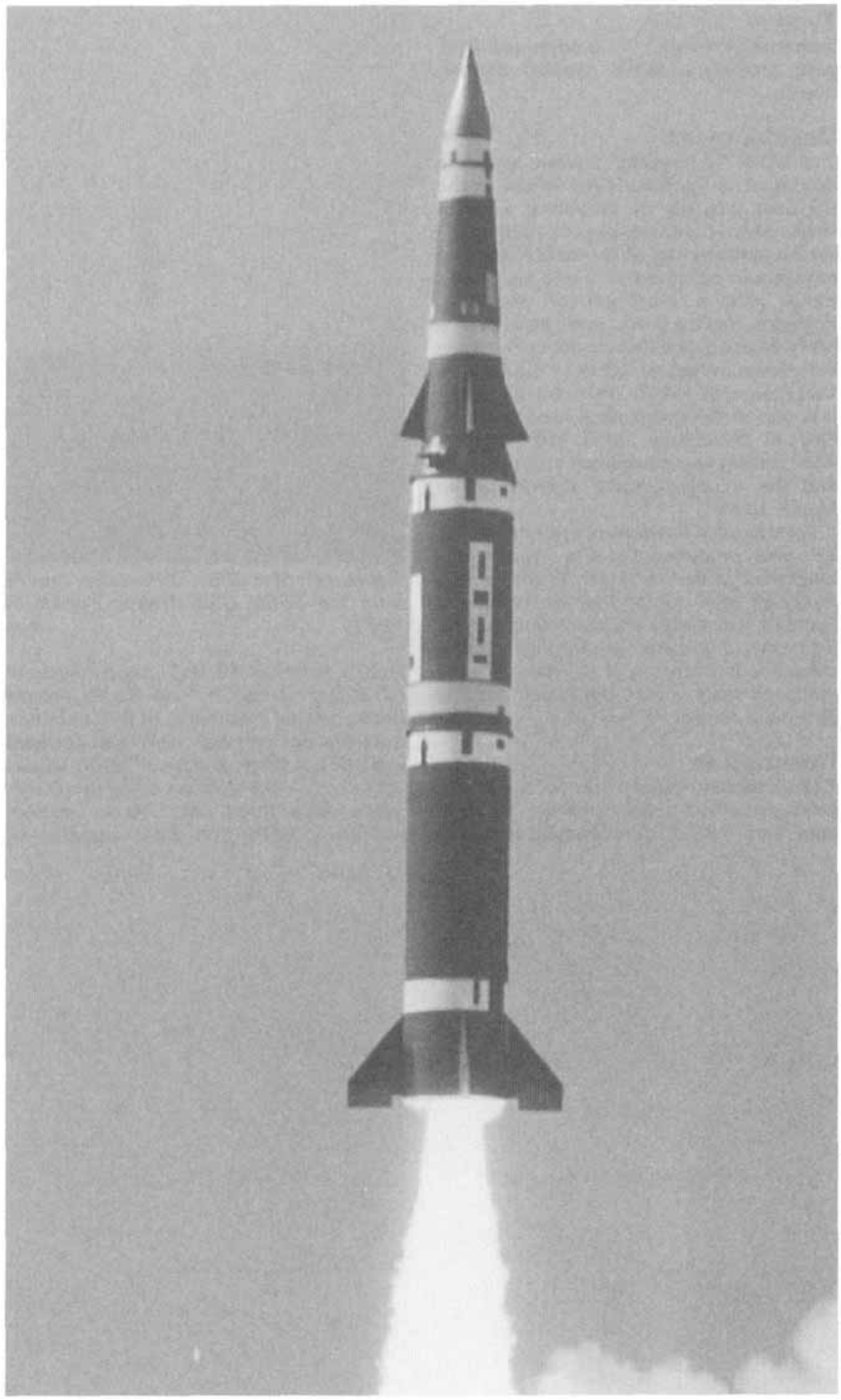
Development
The MGM-31B Pershing II missile was a modification of the Pershing Ia, with improvements to the propulsion and guidance systems; in particular further improving the accuracy down to 50 m CEP. The development programme started in 1976 and the missile entered service in 1984. It is generally considered that the deployment of Pershing II missiles in Europe directly influenced the former Soviet Union to agree to the removal of intermediate-range land-based missiles. (1987 INF Treaty).

Description
Pershing II was an intermediate-range ballistic missile with a length of 10.61 m and a diameter of 1.02 m. The propulsion was a two-stage solid motor, giving the missile a range of 1,800 km. The launch weight was 7,400 kg. The Pershing II had a terminal guidance system based on radar terrain correlation which gave it a claimed accuracy of less than 50 m CEP. The warhead was a W-85 variable yield nuclear, selectable between 5 and 50 kT.

Operational status
The Pershing II missile entered service with the US Army in Europe in 1984, a total of 120 being deployed. It was, however, directly affected by the terms of the 1987 INF Treaty which bans missiles with ranges between 500 and 5,500 km, and by May 1991 all missiles were destroyed. It was reported that the W-85 nuclear warheads were to be installed in modified 661 nuclear freefall bombs.

Specifications
Length: 10.61 m
Body diameter: 1.02 m
Launch weight: 7,400 kg
Payload: Single warhead
Warheads: Nuclear; variable yield, 5 to 50 kT
Guidance: Inertial plus terminal radar homing
Propulsion: 2-stage solid
Range: 1,800 km
Accuracy: 50 m CEP

Contractor
Martin Marietta Electronics and Missile Group, Orlando, Florida (prime contractor) (now Lockheed Martin).



The Pershing II missile at launch

UGM-73 Poseidon C-3

Type

Intermediate-range, submarine-based, solid propellant, MIRV capable ballistic missile.

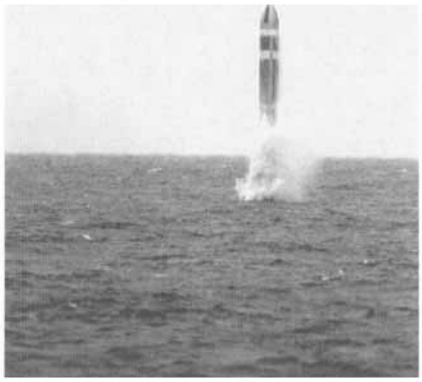
Development

The UGM-73 Poseidon missile was the successor to the Polaris A3 missile in the US fleet, capable of delivering a much larger payload with greater accuracy over a similar range to that of its predecessor. The missile was designed to fit into the Polaris tubes with a minimum of alteration. Poseidon was the first US missile to carry a MIRV payload. The first model of Poseidon was flown in August 1968 at the Eastern Test Range, off Florida. The 14th flight, the first test of the complete weapon system, flew in December 1969. Development flight testing was completed in June 1970 and the missile became operational in March 1971.

An improved fire-control system, the Mk 88, was produced for the missile; this interfaced with the later version of the Rockwell SINS (Ships Inertial Navigation System), the missile and the launcher. The fire-control system performed target calculations, insertion of the data into the guidance system, test and check out and sequence control.

Description

The Poseidon missile was a two-stage, solid propellant ballistic missile 10.36 m long and 1.88 m in diameter. It had a launch weight of 29,480 kg and a range of 4,630 km. It had a Post Boost Vehicle (PBV) capable of carrying 14 RVs, although the usual payload was 10 RVs as declared in START. A throw weight of 2,000 kg was declared in 1991. When carrying 10 RVs these were fitted with 10 kT nuclear warheads, W76; and when carrying 14 RVs these would have been fitted with W68 warheads of 40 kT. The accuracy, at 450 m Circular Error of Probability (CEP), was an improvement of almost a factor of two over the earlier Polaris missile.



The launch of a UGM-73 Poseidon missile from the SSBN USS Casimir Pulaski in 1971 **1989**

Operational status

Poseidon became operational in March 1971 and eventually reached a fleet size of 31 boats and 496 missiles. In 1984 the conversion of Poseidon boats to take the successor system, the Trident C4, began. By 1991 there were 10 Poseidon boats with 160 missiles remaining operational, and by mid-1994 the last Poseidon submarines had been removed from patrol status and prepared for decommissioning. All C-3 Poseidon missiles have been removed from operational service.

Specifications

Length: 10.36 m
Body diameter: 1.88 m
Launch weight: 29,480 kg
Payload: 8-14 RVs on MIRV platform
Warhead: 10 RVs at 100 kT nuclear each
Guidance: Inertial
Propulsion: 2-stage solid propellant
Range: 4,630 km
Accuracy: 450 m CEP

Contractor

Lockheed Martin Missiles and Space

Address

Sunnyvale, California (prime contractor)

MGM-13 Matador/Mace (TM-61/TM-76)

Type

Intermediate-range, ground-launched, turbojet-powered, single warhead cruise missile.

Development

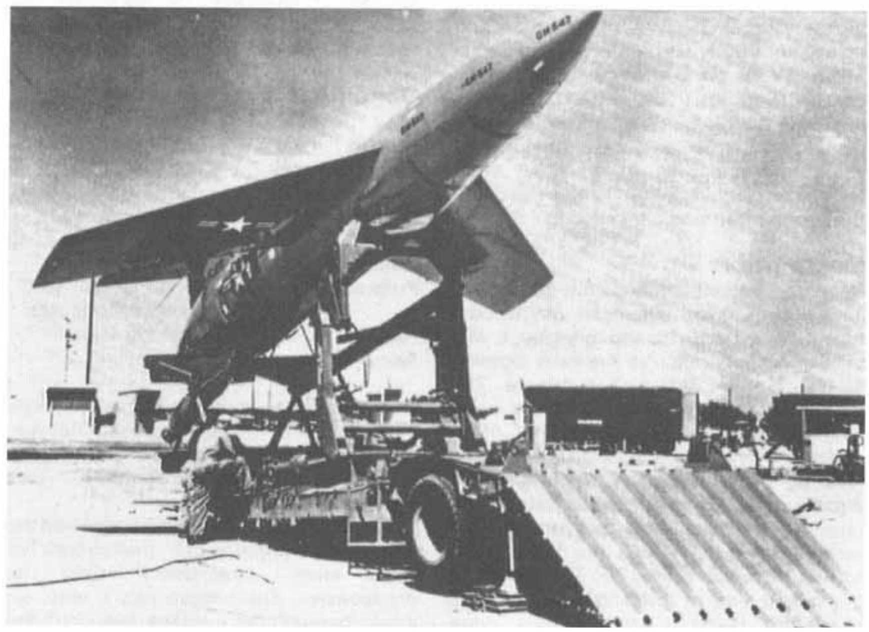
Development of the Matador GLCM was first started by Martin Marietta (now Lockheed Martin) in 1946 when they received a one year contract to study both subsonic and supersonic versions. Flight testing of the Matador, designated TM-61A, commenced in 1949, and between then and 1954 some 46 prototype missiles were tested. Despite some guidance problems the TM-61A Matador entered service in 1954. The problems were mainly that the guidance radar's range was less than the missile's flying range, and the system required a ground-based operator to track and guide the missile. Because of this, in late 1954 the USAF added a guidance system called Shanicle and designated this variant of the missile TM-61C. In this system the missile navigation system used a hyperbolic grid, but although accuracy of the system was improved, the Shanicle still limited the range of the TM-6 1C to that of line of sight transmissions. To overcome this problem, a third guidance system, a radar map-matching system developed by Goodyear, called ATRAN (Automatic Terrain Recognition And Navigation) was installed in the TM-6 1B variant, which was known as Mace. Mace could fly double the range of Matador, and because of these substantial performance improvements, the USAF redesignated Mace TM-76A. Mace entered service in 1959. Further development took place in 1960 to increase the missile's accuracy and this entailed fitting an improved navigational system and inertial guidance. This improved Mace was designated TM-76B, and late MGM-13C.

Description

The Matador and Mace GLCMs were similar in appearance and size to the jet fighter aircraft of that era, having swept back narrow cord wings and high 'T' tail plane. For assisted rocket launch there was a solid propellant jettisonable motor attached beneath the fuselage at the rear. The Matador missiles were 12.10 m long, had a body diameter of 1.20 m and a wing span of 8.70 m. The launch weight including the booster motor was 5,240 kg. The Mace was 14.26 m long, had a body diameter of 1.20 m, a wing span of around 8.00 m and an all up weight at launch including booster motor of 8,500 kg. All variants of both missiles used the same J33 turbojet engine which was updated over the life of the missiles to increase performance.

Guidance for the Matador variants was by command, whereas the early Mace missiles used a radar map-matching system and the later ones had an inertial system. All variants had a payload of 1,360 kg and carried a single W-28 1 MT nuclear bomb as the warhead. The Matador had a maximum range of around 1,000 km when flying a high-altitude trajectory. The Mace TM-61B had a maximum range of 1,900 km when flying at high altitude, and the MGM-13C Mace (TM-76B) was reported to have had a maximum range of 2,000 km from high altitude or 900 km from low altitude.

A Mace guided missile being towed to a deployment site on its mobile launcher



An early TM-61 Matador mounted on its mobile launcher. Note the jettisonable solid propellant booster motor at the missiles rear end

Specifications

	Matador	Mace
Length	12.10 m	14.26 m
Body diameter	1.20 m	1.20 m
Launch weight	5,240 kg	8,500 kg
Payload	Single warhead 1,360 kg	Single warhead 1,360 kg
Warhead	W-28 1.0 MT nuclear	W-28 1.0 MT nuclear
Guidance	Command	Inertial
Propulsion	Turbojet	Turbojet
Range	1,000 km	1,900 or 2,000 km
Accuracy	n/k	n/k

Operational status

The TM-61A Matador entered service with the USAF in 1954 and became operational in Germany in 1955. The TM-61B Mace was deployed to serve alongside Matador in Europe in 1959 and the latter was phased out in 1962. Eventually, six missile squadrons (comprising 38th Tactical Missile Wing) served in Europe with just under 200 TM-61B Mace and the improved MGM-13C Mace (TM-76). The USAF missile squadrons were deactivated in 1969 as the US Army's Pershing missiles took over the Quick Reaction Alert Force. About 60 TM-61s were also deployed in Korea between 1959 and 1962.

Contractor

The prime contractor for Matador/Mace was Martin Marietta Corporation (now Lockheed Martin).

SSM-N-8/-9 Regulus 1 and 2

Type
Intermediate-range, sea-launched, turbojet-powered, single warhead cruise missile.

Development
The Regulus 1 was a subsonic cruise missile. designated SSM-N-8. and was developed by the USN to diversify and supplement its carrier based aviation with missile power. Chance Vought (now Lockheed Martin) began development of the Regulus 1 system in 1947 The nuclear warhead chosen for the Regulus 1 was W-5, however, it is reported that in late production models this was replaced by a higher yield W-27. The missile was first tested in 1951 and entered service in 1955 Work on a supersonic improved version, Regulus 2 designated SSM-N-9, began in 1952. Regulus 2 used a newly developed inertial guidance system, and the range and size of warhead were increased Regulus 2 first flew in 1956, but the programme was cancelled in 1958.

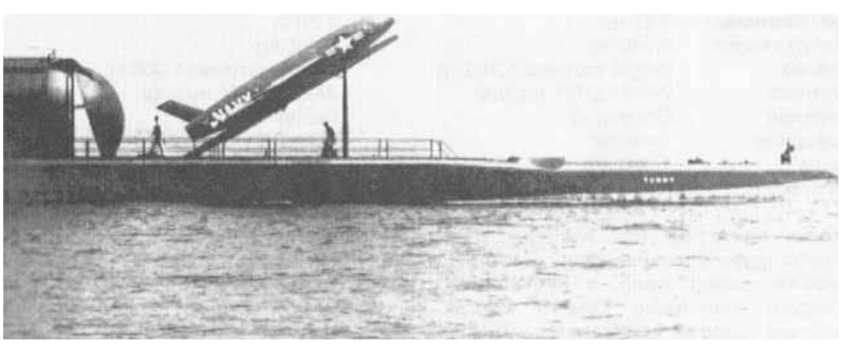
Description
Regulus 1 had the general configuration of a small aircraft with two delta wings and a triform swept back fin and tailplane It was similar in appearance to the early Russian SS-N-2 'Styx' ship-launched missile The missile was 10.58 m long, had a body diameter of 1 22 m, a wing span of 6 40 m and a launch weight of 6,800 kg Guidance was by radio command, with a chase aircraft determining the flight path of the missile. The propulsion unit was a J33 turbojet, which gave the missile a maximum speed of MO 85 The launch of the missile was assisted by a pair of solid propellant boost motors, which were jettisoned after launch Early versions of the Regulus 1 carried a single W-5 nuclear warhead. Later versions carried a single improved W-27 nuclear warhead that was reported to be in the mid-kT range. The maximum range of the Regulus 1 was 740 km.

The Regulus 2 cruise missile also had the general configuration of a small aircraft but was more streamlined than its predecessor. The missile had a large air intake beneath the fuselage, level with the leading edge of the wings. The missile was 20.48 m long, had a body diameter of 1.25 m, a wing span of 6.30 m and a launch weight of 13,600 kg. Guidance was inertial, and operated the wing and tail control surfaces. The propulsion unit was a J79 turbojet which gave the missile a maximum speed of M2.0 when flying at high altitude, although for maximum range the missile cruised at M I.2. The launch of the missile was assisted by a large solid propellant jettisonable booster motor mounted beneath the air intake. The missile's payload was 1,325 kg and consisted of a single nuclear warhead. The maximum range of the Regulus 2 was reported to be 1,850 km.

The first firing of a Regulus 2 cruise missile from the USS Greyback in September 7958

Specifications

	Regulus 1	Regulus 2
Length	10.58 m	20.48 m
Body diameter	1.22 m	1.25 m
Launch weight	6,800 kg	13,600 kg
Payload	Single warhead	Single warhead
Warhead	W-5 or W-27 nuclear	Nuclear
Guidance	Command	Inertial
Propulsion	Turbojet with solid propellant booster	Turbojet with solid propellant booster
Range	740 km	1,850 km
Accuracy	n/k	n/k



A Regulus 1 cruise missile ready to fire from the deck of the USS Tunny submarine. The structure behind the missile was the on-deck watertight missile container

Operational status
Regulus 1 entered service with the USN in 1955. Some 157 launchers and 500 missiles were in service on five submarines, four cruisers and 10 aircraft carriers. The missile was retired from service in 1964. Regulus 2 did not enter service, as the programme was cancelled in 1958 in favour of submarine-launched ballistic missiles. About 20 development Regulus 2 missiles were built.

Contractor
The prime contractor for Regulus 1 and 2 was Chance Vought (now Lockheed Martin).

SM-62 Snark

Type

Intercontinental-range, ground-launched, turbojet-powered, single warhead cruise missile.

Development

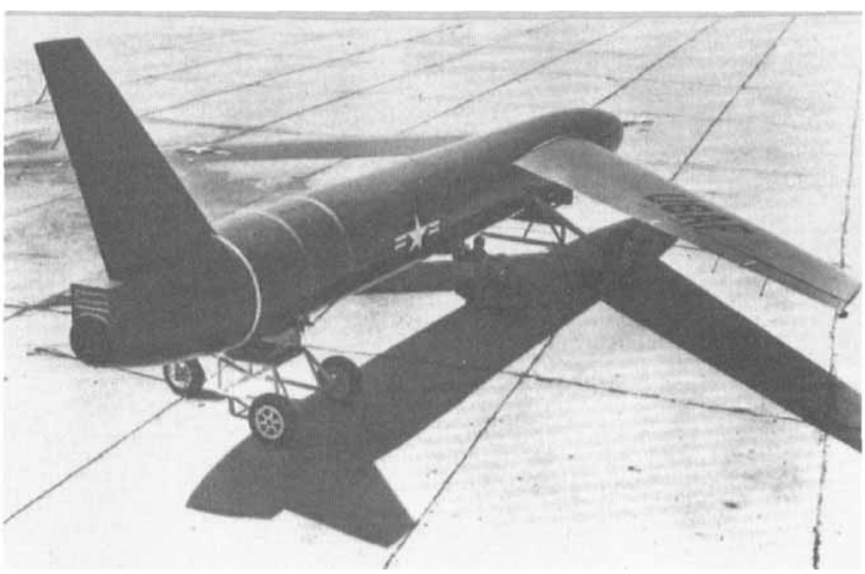
In 1945, the USAF established a requirement for a 8,000 km range cruise missile with a 900 kg warhead. Northrop presented a proposal in 1946 for a subsonic, turbojet-powered, 4,800 km range missile and the company received one year research and study contracts for both a subsonic and a supersonic missile with a range from 2,400 to 8,000 km and a 2,267 kg payload. These missiles were known as Snark (designation MX-775A) and Boojam (designation MX-775B, this programme was later cancelled). In 1949 the USAF authorised 10 flight tests of the Snark, now designated N-25 by Northrop, and in 1951 the first successful test flight took place. In 1950, the USAF had increased the Snark requirements to include a supersonic dash at the end of the 8,000 km mission, a payload of 3,000 kg and a CEP of 457 m. As a result Northrop produced a new design, which was basically a scaled-up N-25, and this (the N-69) was initially called 'Super Snark. Testing of the new missile, designated SM-62A, began in 1952. The first nuclear warhead considered for fitment to the Snark missile was the W-4. However, the warhead finally selected for Snark was the W-39, which had been developed as a two yield device for the US Army's Redstone tactical missile programme. Despite several development problems and the fact that test results indicated that Snark had only a one in three chance of getting off the ground, and only one of the last 10 launches went the planned distance, the USAF authorised production and it entered service in 1960.

Test launch of an early SM-62A Snark on 12 February 1960. Note two jettisonable solid propellant boosters on either side of the rear fuselage and underwing drop tanks

Description

The SM-62A Snark missile was a large aircraft configured missile. It was unusual in that it had no horizontal tailplane and flight control was carried out by elevons on the wings and a small rudder on the vertical fin. The swept back narrow cord wings had a distinctive 'saw tooth' leading edge and each carried a pylon-mounted drop tank. The SM-62A missile was 20.50 m long, had a body diameter of 1.40 m, a wing span of 12.80 m and a launch weight of 22,225 kg. The propulsion unit was the J57 turbojet engine which developed a thrust of 4,309 kg and gave the missile a maximum speed of M0.8. The guidance system was a stellar inertial system.

The warhead nose section was 3.65 m long, had a diameter of about 0.90 m and weighed a total of 2,812 kg. This contained a W-39 Y1 nuclear warhead that had a yield of 1 MT. The entire warhead compartment separated from the missile just prior to reaching the target and continued on a ballistic trajectory. The rest of Snark broke up and thus produced several decoy radar returns. The missile could be launched either from a fixed or towed launcher, and was assisted by two solid propellant jettisonable booster motors mounted on either side of the rear fuselage section. The missile's maximum range was reported to be 8,800 km, but it was very inaccurate. On test flights out to 3,500 km the missile averaged a CEP of 32 km. In fact the most accurate full range test flight impacted 7.7 km left and 0.55 km short; it was the only test ever to reach the target.



A prototype Snark designated N-25 by Northrop. prior to its first successful flight on 16 April 1951. Note lack of horizontal tail plane

Operational status

The SM-62A Snark entered service with the USAF in 1960, however the Snark did not remain in service long. Shortly after taking office in 1961 President Kennedy scrapped the project, calling the missile both obsolete and of marginal military value relative to ballistic missiles. The USAF deactivated the Strategic Missile Wing on 25 June 1961, thus making the unit and Snark's service one of the briefest in US military history. It has been reported that some 30 W-39 warheads were manufactured for the Snark.

Specifications

Length: 20.50 m
Body diameter: 1.40 m
Launch weight: 22,225 kg
Payload: Single warhead
Warhead: W-39 Y1 1 MT nuclear
Guidance: Inertial
Propulsion: Solid booster and turbojet
Range: 8,800 km
Accurcy: n/k

Contractor

The prime contractor for SM-62A Snark was Northrop Corporation, California.

BGM-109G Griffin

Type
Intermediate-range, road mobile, turbofan-powered, single warhead cruise missile.

Development
The BGM-109G Griffin was a ground-launched variant of the RGM/UGM-109 Tomahawk family of missiles, which started development in 1972 and first entered service in 1984. The Ground Launched Cruise Missile (GLCM) variant was similar to RGM/UGM-109A, the nuclear land attack ship and submarine-launched cruise missile. The INF Treaty banned the use of intermediate-range ground-launched cruise missiles, and so the Griffin missiles in Europe were all removed by 1991.

Description
BGM-109G Griffin was 6.40 m long, including a solid propellant boost motor mounted at the rear of the missile, had a body diameter of 0.52 m and an unfolded wing span of 2.67 m. The launch weight, including boost motor, was 1,470 kg. The missiles had a Williams International F 107-WR-400 turbofan engine, weighing 65 kg and producing around 600 lb (272 kg) of thrust. The boost motor was used to accelerate the missile from its launcher container and was jettisoned in flight after the turbofan engine started. Guidance for the Griffin missile was inertial, with terrain contour matching updates at selected waypoints over land. Terrain contour matching (tercom) was achieved by storing digital terrain profile maps in the missile before launch. This data was then compared with radar altimeter measurements of ground elevations below the missile during a set number of sections on route to the target. BGM-109G Griffin had a single nuclear warhead W-84, with variable preset yields between 10 and 50 kT, that could be set for air or surface burst options. The missile had a range capability of 2,500 km, and an accuracy reported to be 80 m CEP. BGM-109G was carried in a road mobile transporter erector-launcher vehicle, and each vehicle carried four missiles in canisters. The TELs could be carried by C-130, C-141 and C-5 aircraft.

Operational status
The BGM-109G missiles began deploying to Europe in 1984, where they were operated by USAF personnel. At the time of declaration of data for the INF Treaty, in November 1987, there were a total of 322 missiles deployed and 95 TEL vehicles, as well as a further 121 non-deployed missiles and 28 TELs. All the missiles were destroyed by May 1991.

Specifications
Length: 6.40 m
Body diameter: 0.52 m
Launch weight: 1,470 kg
Payload: Single warhead
Warhead: 10 to 50 kT nuclear
Guidance: Inertial and tercom
Propulsion: Solid booster and turbofan
Range: 2,500 km
Accuracy: 80 m CEP

Contractors
General Dynamics Convair Division, San Diego, California (prime contractor) (now Hughes Missile Systems). McDonnell Douglas Missile Systems, St Louis, Missouri (second source).

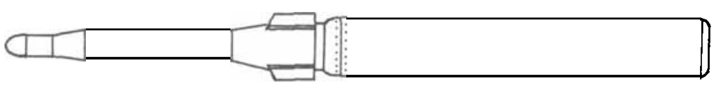
BGM-109G Griffin ground-launched cruise missiles and the transporter-erector-launcher vehicle

UUM-44 SUBROC

Type
Short-range, submarine-launched, solid propellant, single warhead anti-submarine missile.

Development
The SUBROC (Submarine-launched Rocket) concept originated within the US Navy's Bureau of Ordnance in 1953. The original requirement was for a solid propellant, torpedo tube-launched bombardment missile; in time, the concept was revised so that it became primarily an ASW weapon, with provision for an airburst warhead to retain a bombardment capability. Development of the missile started in 1958 at the US Naval Ordnance Laboratory, under the management direction of the Bureau of Naval Weapons, with Loral Systems Group (formerly Goodyear Aerospace Corporation and now Lockheed Martin Tactical Systems) as the prime contractor. Technical evaluation was completed in 1964, and production and operational deployment began in 1965. UUM-44 SUBROC missiles were fitted to submarines of the 'Los Angeles', 'Glenard P Lipscomb', and 'Sturgeon' class. Each submarine carried four to six missiles.

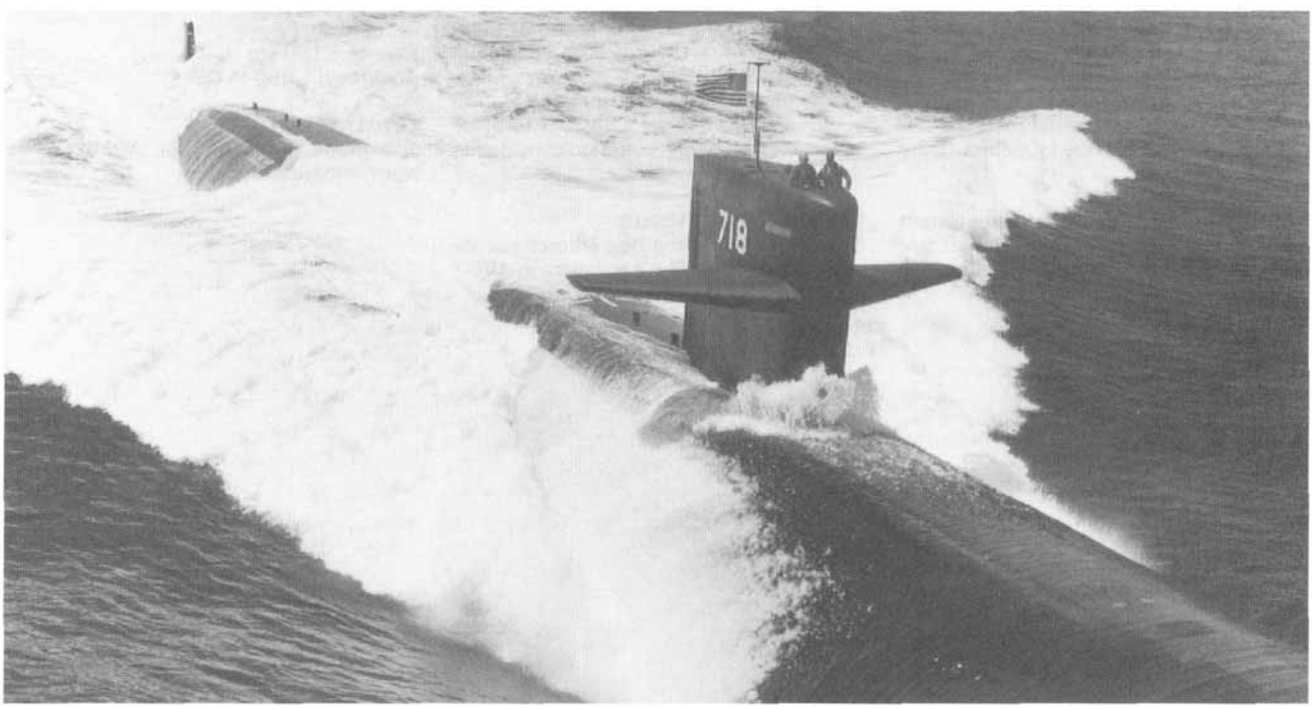
Description
SUBROC was the first tactical weapon capable of underwater launch, rocket motor ignition, guided airborne trajectory and underwater detonation. The weapon is basically a guided missile with a nuclear depth bomb at its front end. The bomb has four small aerodynamic control and stabilising fins. The missile is 6.70 m long, has a body diameter of 0.53 m and weighs 1,814 kg at launch. The warhead is fitted with a W55 nuclear bomb, which weighs 300 kg and has a yield of between 1 and 5 kT. The UUM-44 missile forms part of an advanced ASW system, which includes the AN/BQQ-2 Raytheon integrated sonar system and the Mk 113 SUBROC fire-control system. After detection and location of the target submarine the missile is launched horizontally from a standard 21 in (533 mm) torpedo tube. At a safe distance from the launch vessel (which need not be directed towards the target area for firing) the solid propellant motor is ignited and the missile follows a short level path before being directed upward and clear of the water. Missile stability and steering is affected by four jet deflectors, which function in both water and airborne sectors of the trajectory. When free of the water, SUBROC is accelerated to a supersonic speed and inertially guided towards the target area. At a predetermined point, separation of the nuclear depth bomb is initiated by explosive bolts and a thrust-reversal deceleration system that enables the warhead to continue on a controlled trajectory. Impact with the water is cushioned to protect the arming and detonation devices. A preset depth sensor detonates the nuclear charge when the bomb is in the vicinity of the target. The SUBROC missile has a range of 55 km and the warhead is estimated to have a lethal radius of 5 to 8 km.


An outline diagram of the UUM-44 SUBROC missile

Operational status
UUM-44 SUBROC entered service in 1965 and initial production was completed in 1968, however the production line was re-opened from 1972 until 1974. In all some 285 warheads were produced and were in operational service, installed on 16 nuclear-powered attack submarines. An improvement programme to sustain the effectiveness of this weapon against new threats was initiated in 1976-77. A Congressional decision was taken in 1979 not to update the system and as a consequence the USN turned to the ASW-SOW (Sea Lance) programme to meet existing and anticipated requirements. The SUBROC system is now considered obsolescent and it has been phased out in favour of conventional Mk 48 torpedoes. The Sea Lance programme was terminated by the USN in 1989.

Specifications
Length: 6.70 m
Body diameter: 0.53 m
Launch weight: 1.814 kg
Payload: 300 kg single warhead
Warhead: 1-5 kT (W-55). nuclear
Guidance: Inertial
Propulsion: Solid propellant
Range: 55 km
Accuracy: n/k

Contractor
Loral Systems Group, Akron, Ohio (now Lockheed Martin Tactical Systems).



A Los Angeles class attack submarine, which could carry up to six UUM-44 SUBROC missiles (US Navy)

AGM-28 Hound Dog (GAM-77)

Type
Intermediate-range, air-launched, ramjet-powered, single warhead cruise missile.

Development
Studies of the development of the GAM-77 Hound Dog began in 1956 when the USAF issued a General Operations Requirement for an air-to-surface missile for the 6-52 bomber aircraft. The design requirements called for a 4 MT nuclear warhead (later reduced to 1 MT) to be carried a maximum range of 560 km, at M2.0 at over 17,000 m (55,000 ft) altitude. The contract for the development and production of Hound Dog was awarded to North American Aviation in 1957. The W-28, a 1 MT warhead, which had been developed for the Mk 28 bomb, was selected for Hound Dog. In 1958 growing concern about both the perceived unfavourable shift in the strategic balance and the increasing vulnerability of penetrating bombers prompted the USAF to accelerate development of the GAM-77, now designated AGM-28. In 1959 compatibility of the W-28 warhead to the Hound Dog missile was established and the first prototype missile was successfully tested. The first production AGM-28A Hound Dog was delivered to the Strategic Air Command (SAC) in December 1959 and SAC launched its first AGM-28A in February 1960. Because of certain deficiencies in the initial production missiles, development continued and an improved version GAM-77A designated AGM-28B was introduced into service in 1961.

The B-52 could carry two of the missiles, one on each of its two underwing inboard pylons, although the two missiles degraded the 6-52 flight performance. However, the SAC crews found that they could shorten the B-52s take off run by using the Hound Dog engines in addition to the bombers eight engines, and bomber fuel could then be transferred to the missiles before they were launched.

Description
AGM-28 Hound Dog was a streamlined, long slender missile with a canard and delta wing configuration. Under the rear half of the fuselage was a large ramjet engine on a short pylon. The missile was 12.95 m long, had a body diameter of 0.72 m, a wing span of 3.70 m and a launch weight of 4,350 kg. Guidance was by a self-contained inertial system produced by North American's Autonetics Division that operated the canard and wing control surfaces. The propulsion unit was the Pratt & Whitney J52 ramjet engine, which developed a thrust of 3,400 kg. The engine had a centre-body air intake and a variable propulsive nozzle to modulate the thrust and turbine temperature under different flight conditions. The missile payload was 790 kg and consisted of a W-28 nuclear warhead that had a yield of 1 MT.

When launched in its high-level profile, Hound Dog had a cruising speed of M2.0 and range of 1,180 km. The maximum range at low level was 630 km with a speed of M0.83 at 300 m altitude. The accuracy of the missile, 1,850 m CEP at full range, was probably adequate considering the yield of the warhead.


An AGM-28 Hound Dog underneath a B-52 bomber (Peter Humphris) *2002*/0132981

Operational status
The AGM-28A Hound Dog entered service with the USAF on 6-52 bombers in 1960. This was followed by AGM-28B in 1961. The numbers of Hound Dog missiles in the 6-52 fleet grew rapidly from 54 in 1960, rising to 593 in 1963 of which over 400 were AGM-286s. and by this time 29 SAC wings were operational with the AGM-28. Hound Dog production ended in 1963 and the number of missiles declined to 308 in 1976. The USAF phased out the Hound Dog in 1976, replacing it with the smaller AGM-69 SRAM.

Specifications
Length: 12.95 m
Body diameter: 0.72 m
Launch weight: 4,350 kg
Payload: Single warhead 790 kg
Warhead: W28 1.0 MT nuclear
Guidance: Inertial
Propulsion: Ramjet
Range: 1,180 km
Accuracy: 1,850 m CEP

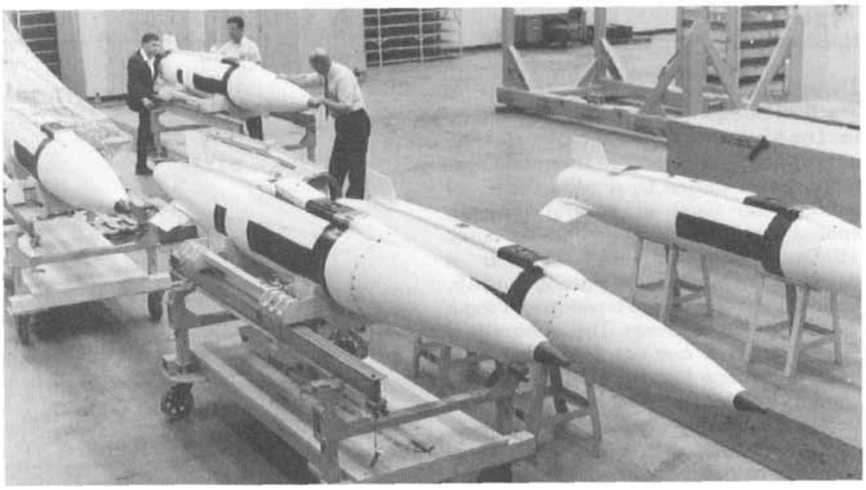
Contractor
The prime contractor for AGM-28 was North American Aviation.

AGM-69 SRAM

Type
Short-range, air-launched, solid propellant, single warhead, air-to-surface missile.

Development
The Short-Range Attack Missile (SRAM) was so named because it was necessary to differentiate between that missile and the development of cruise missiles that were taking place together for the USAF in the late 1960s. SRAM-A entered service in 1972, followed later by SRAM-B. Production finished in 1977 at which time 1,500 missiles had been produced and cleared for carriage on the B-52 Stratofortress, F-111 Raven and B1-B Lancer aircraft. The B-52 could carry up to 20 SRAMs, the F-111 up to six, and the B1-B up to 24.

In the late 1980s development began on an updated version of AGM-69, called SRAM 2 and designated AGM-131; this was due to difficulties with some safety aspects of the nuclear warhead on the AGM-69 missile together with motor limitations. However, the replacement AGM-131 programme was terminated in 1992. In 1992 proposals were made to modify AGM-69 SRAM missiles for use as the boost stage of an airborne anti-ballistic missile for use against short-range tactical ballistic missiles. Firing trials were carried out to confirm the stability of SRAM at altitudes around 30 km (100,000 ft), but the programme was terminated in 1993. In 2000, Orbital Sciences and Raytheon were awarded a contract to develop a supersonic anti-ship target for the US Navy. using AGM-69 missiles.


AGM-69 SRAM in a USAF weapons preparation area


A practice AGM-69 missile being loaded onto an FB-111 aircraft 0008589

Description
AGM-69 SRAM was a streamlined, slender cylindrical missile that had a sharply pointed conical nose, and rectangular fin and anhedral tailplanes with swept leading-edges at its rear end. The missile was 4.27 m long, had a body diameter of 0.45 m, and a tailspan of 0.9 m. SRAM's weight at launch was 1,016 kg and it carried a single W69 nuclear warhead rated at 170 kT.

Guidance was inertial aided by a radar altimeter, that could be programmed for high or low altitude flight profiles after launch. When launched in its high-level profile, the solid propellant motor gave SRAM a cruising speed of M3.0 and a range of 200 km. The CEP was reported to be 450 m.

Operational status
AGM-69 entered service with the USAF in 1972, with a total of 1,500 missiles being built over a five year period. It was reported that some 1,100 missiles remained in inventory in 1988, and that difficulties with safety aspects of the nuclear warhead together with motor limitations promoted the development of AGM-131 SRAM 2. Subsequent concerns for the safety aspects of the W69 warhead resulted in the withdrawal of AGM-69 missiles from day-to-day operations on ground alert aircraft from December 1990. There were no known exports. In 2000, a US Navy contract was awarded for the development of a supersonic anti-ship target, with six targets to be built for evaluation trials that will be carried out between 2001 and 2004.

Specifications
Length: 4.72 m
Body diameter: 0.45 m
Launch weight: 1.016 kg
Payload: Single warhead
Warhead: W69, 170 kT
Guidance: Inertial
Propulsion: Solid propellant
Range: 200 km
Accuracy: 450 m CEP

Contractor
Boeing Aerospace, Seattle, Washington (prime contractor).

B28 Nuclear bomb

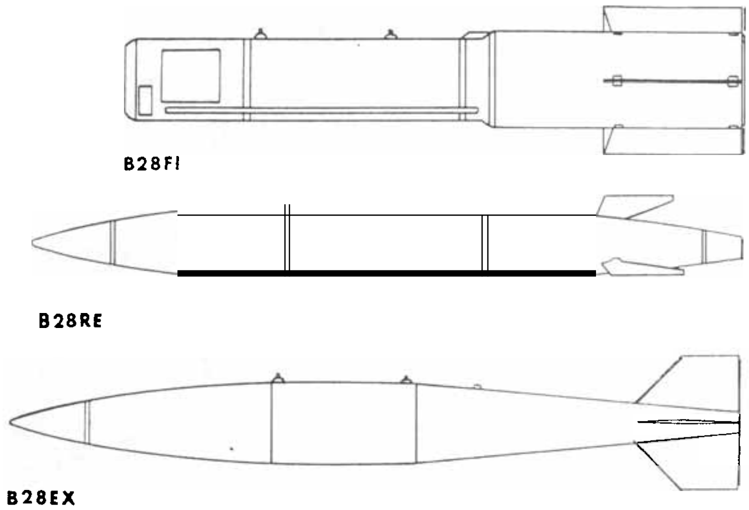
Type

Nuclear bomb

Development

The B28 nuclear bomb was developed by the Los Alamos National Laboratory (LANL) as a strategic and tactical thermonuclear bomb to be carried by a wide variety of aircraft and used in several different applications. Studies began in the early 1950s. which led the way to a development programme starting in 1955, five different types were developed using a 'building block concept. These were the: B28EX external carriage free-fall; B28IN internal carriage free-fall: B28FI internally carried free-fall or parachute retarded; B28RE externally carried free-fall or parachute retarded: and the B28RI internally carried, parachute retarded.

Production started in 1957 and initial deployment of the Mod 0 version was in 1958, Mod 1 followed in 1960 and Mod 2 in 1961. Over the years there were several warhead improvement programmes to the B28 bomb until its replacement, the B83, became available in the mid-1980s. The various types were all fitted with standard 762 mm spaced suspension lugs and appropriately cleared for internal or external carriage on the B-52 Stratofortress and B-1B Lancer bombers, and a wide variety of dual capable tactical aircraft including the: A-4 Skyhawk; A-6 Intruder; A-7 Cosair; F-4 Phantom: F-104 Starfighter; Canberra and Valiant. The B28 warhead (designated W28) was also used in the Hound Dog and Mace missiles, both of which have also been withdrawn from service.



Outline diagrams of the last three B28 nuclear bombs to leave the service

Specifications

	B28EX	B28RE	B28FI	B28IN	B28RI
Length	4.32 m	4.20 m	3.68 m	2.40 m	3.38 m
Body diameter	0.50 m	0.50 m	0.56 m	0.50 m	0.56 m
Tailspan	0.80 m	0.56 m	0.80 m	0.71 m	n/k
Lug spacing	762 mm	762 mm	762 mm	762 mm	762 mm
Weight	925 kg	984 kg	1,061 kg	898 kg	1,061 kg
Yield	Nuclear 70 kT, 350 kT, 1.1 MT or 1.45 MT				
Accuracy	n/k	n/k	n/k	n/k	n/k

Description

The B28 was a strategic and tactical thermonuclear bomb which used a building block concept to produce five different versions.

The B28EX was an externally carried, free-fall, supersonic capable, streamlined bomb with a pointed nose and a conventional conical four fin tail unit. It was 4.32 m long, had a body diameter of 0.5 m, a tailspan of 0.8 m and weighed 925 kg. The B28EX bomb had radar fuzing for either airburst or groundburst functioning, and had Category B Permissive Action Link (PAL) incorporated (this permitted the weapon to be enabled or access gained to the warhead itself with the correct code).

The B28IN was an internally carried high drag, free-fall bomb with a blunt nose and a large diameter short conical tail unit with four rectangular stabilising fins. It was the smallest of the five bombs, being 2.40 m long, having a body diameter of 0.50 m, a tailspan of 0.71 m and weighing 898 kg. The B28IN bomb had fuzing for either airburst or groundburst functioning with Cat B PAL.

The B28FI was an internally carried, high-drag, free-fall or parachute-retarded bomb with a blunt nose and a large canister type tail unit with four rectangular stabilising fins. This bomb was 3.68 m long, had a maximum body (canister tail unit) diameter of 0.56 m, a tailspan of 0.8 m and weighed 1,061 kg. The B28FI bomb had full fuzing options including free-fall ground, free-fall airburst, retarded ground, retarded airburst, laydown and delayed groundburst all functioning with Cat B PAL.

The B28RE was an externally carried, low-drag free-fall or parachute-retarded bomb with a streamlined pointed nose and a tapered tail unit with three swept-back stabilising fins. This bomb was 4.20 m long, had a body diameter of 0.50 m, a tailspan of 0.56 m and weighed 984 kg. The B28RE bomb had radar fuzing for either airburst or groundburst functioning with Cat B PAL.

The B28RI was an internally carried, high-drag, parachute-retarded bomb with a rounded 'false nose' and a canister type tail unit with four rectangular stabilising fins. The nose was made of frangible aluminium honeycomb and was designed to absorb impact forces when the parachute-retarded bomb touched down.

This bomb was 3.38 m long, had a maximum body (canister tail unit) diameter of 0.56 m and weighed 1,061 kg. The B28RI bomb had ground and airburst fuzing, but appears not to have had PAL.

The W28 warhead itself was approximately 0.9 m long and contained Plutonium, Lithium-6 Deuteride and Tritium for fusion and probably PBX-9505 or Cyclotrol as the primary high explosive. Each individual bomb had only one yield, and of the five different yields that existed only four are known; 70 kT, 350 kT, 1.1 MT and 1.45 MT. The fuzing option had to be selected on the ground by maintenance personnel for air or ground burst. Only the B28FI had a laydown option with a minimum delivery of 90 to 180 m, and could be delivered over the shoulder and at low or medium angle loft.

Operational status

The first of the B28 family of bombs entered service with the USAF in 1958 and some other NATO Air Forces. Production ceased in 1970 after approximately 1,200 bombs had been made, and in 1987 it was reported that an estimated 1,000 Mk 28s remained in the US nuclear weapons inventory. Withdrawal from service of the B28s started in 1984 and it is believed that withdrawal was completed in 1995.

Contractor

Not known.

B43 Nuclear bomb

Type

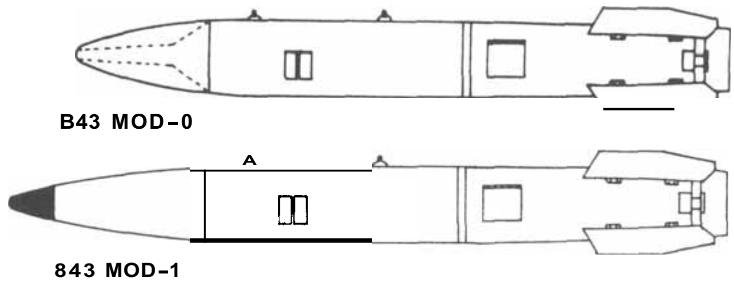
Nuclear bomb.

Development

Development of a low-drag, parachute retarded, shock-resistant, implosion bomb for high-speed, low-altitude 'laydown' delivery was authorised in 1955 and the 680 kg 'laydown' bomb was assigned the designation TX-43 (and later became the 643). Development began at the Los Alamos National Laboratory (LANL) and in order to meet two distinct requirements the bomb was designed to be fitted with two interchangeable noses that were designated Mod 0 and Mod 1. The Mod 0 nose was designed with a steel spike to penetrate hard targets and hold the bomb in place upon impact for delayed surface (laydown) burst. Drop tests in 1957 proved the utility of a nose spike for impact shock mitigation. The Mod 1 nose is more streamlined and was designed to carry an airburst radar fuze system. Both versions of the bomb were design-released in 1960 and accepted for production as the B43. Initial deployment of the Mod 0 was in 1961, followed by the Mod 1 in 1962. Over the next few years updated versions of the 643 were introduced with new safety and delivery features. These updated versions were designated Mod 2, 4 and 5. Production had ceased by 1970 after approximately 1,000 843 bombs had been manufactured. For training purposes several different types of practice bomb were produced and these were designated BDU-6, BDU-8, BDU-18 and BDU-24. All variants of the B43 are fitted with 762 mm spaced suspension lugs and cleared for internal or external carriage on the 6-52 Stratofortress, FB-111, F-4 Phantom, F-16 Fighting Falcon, F-111 Raven, A-4 Skyhawk. A-6 Intruder. A-7 Corsair, Canberra, Valiant and Tornado aircraft.

Description

The B43 was a low-drag, high-yield strategic and tactical thermonuclear bomb which had an aerodynamically shaped body with a four fin tail configuration.



Outline diagrams of the *843* Mod 0 and Mod *I nuclear bombs*

The bomb was made up of three separate sections; the nose-section which could be a choice of two, designated Mod 0 and Mod 1, a centre assembly that contained the warhead and was fitted with 762 mm spaced suspension lugs and the tail assembly that contained the retarding parachute. With the spiked Mod 0 nose fitted the 643 was 3.8 m long, had a body diameter of 0.46 m, a tailspan of 0.86 m and weighed 936 kg. The Mod 1 version with its longer more streamlined nose was 4.16 m long, had a body diameter of 0.46 m, a tailspan of 0.86 m and weighed 964 kg. The warhead, common to both types contained Oralloy as the fissile material and Lithium-6 Deuteride and Tritium for fusion and had a yield of 1MT.

The Mk 43 bomb with the Mod 0 nose section installed was a single purpose, parachute retarded 'laydown' weapon. The nose section had a ballistic covering for the spike that was weighted to facilitate nose cone separation from the bomb. The nose release mechanism was triggered when the bomb was released from the delivery aircraft. When the retarding parachute deployed, bomb deceleration separated the nosecone from the rest of the bomb to expose the spike on the forward end of the centre bomb assembly. The Mod 0 nose allowed only one fuzing option, parachute retarded 'laydown'. The Mod 1 nose section contained a fuzing radar set and when installed the B43 became a multipurpose weapon that had four fuzing options; freefall airburst, retarded airburst with or without surface burst if the bomb failed to detonate in the air, and retarded laydown. The Mod 1 bomb was also fitted with Permissive Action Link (PAL), which permitted the weapon to be enabled or access to the warhead itself with the correct code. Fuzing options had to be selected on the ground by maintenance personnel for air or ground burst. The bomb, which had a minimum delivery altitude of 90 to 180 m (300 to 600 ft). can also be delivered over the shoulder and at low or medium angle loft.

Operational status

The B43 entered service in 1961 and completed production in 1970. In 1987 an estimated 975 of the updated MK 43s remained in service with the USAF, USN, US Marine Corps and certain NATO Air Forces.

It was reported in 1995 that all B43 bombs had been withdrawn from service and stored in the USA awaiting disposal.

Specifications

Length: 3.8 m (Mod 0); 4.16 m (Mod 1)
Body diameter: 0.46 m
Tailspan: 0.86 m
Lug spacing: 762 mm
Weight: 936 kg (Mod 0); 964 kg (Mod 1)
Yield: 1MT
Accuracy: n/k

Contractor

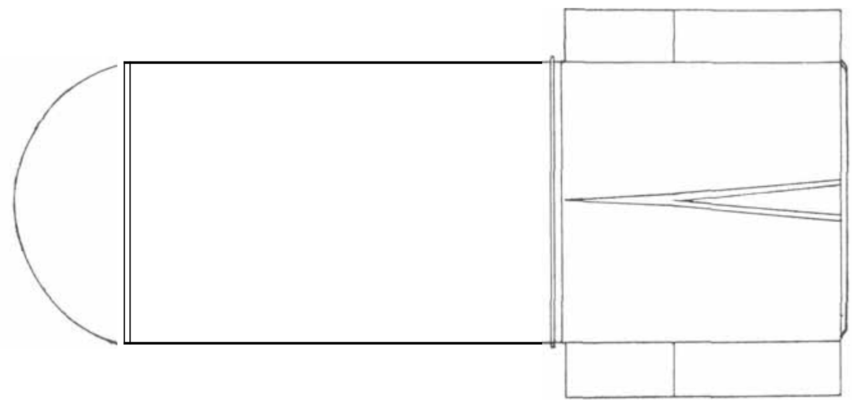
Not known.

B53 Nuclear bomb

Type
Nuclear bomb

Development
In early 1958, the USAF requested the development of a new high-yield thermonuclear bomb with full-fuzing options (FUFO) to replace the Mk 43 aerial bomb. The new bomb was designated the B53, and development started in 1958 at the Los Alamos National Laboratory (LANL). The B53 was designed as a high-yield strategic bomb for internal carriage by the B-52 Stratofortress bomber. Production engineering began in 1960 and full production followed in 1961. Initial deployment was in 1962. Production of the B53 ceased in 1965 after approximately 340 bombs had been made and retirement of early mods began in July 1967. It is believed that the warhead was further developed and used in the Mk-6 re-entry vehicle carried by the Titan 2 missile, where it was designated W-53.

Description
The B53 was a high-yield strategic thermonuclear bomb which was internally carried by the 8-52 bomber and looked like a large can with a rounded nose. At the rear end were four rectangular stabilising fins of broad wedge profile. The B53 was 3.76 m long, had a diameter of 1.03 m, a tailspan of 1.80 m and weighed 4,022 kg. The warhead contained Oralloy as the fissile material and Lithium-6 Deuteride for fusion and had a yield of 9 MT. Fuzing options had to be selected on the ground by maintenance personnel and the weapon did not appear to have Permissive Action Link (PAL). The bomb could be delivered in the following methods: airburst; contact-burst; laydown; free-fall; or retarded delivery. For retard operation the bomb had a parachute system weighing around 400 kg, consisting of three 15 m parachutes, one 5 m and one 1.5 m pilot chute. Free-fall delivery was achieved by blowing out the parachute can and jettisoning all parachutes.



An outline diagram *of the B53* nuclear *bomb*

Operational status
The B53 entered service in 1962 and production ceased in 1965. About 25 bombs remained in service with the USAF in 1987 and were to be replaced by the lower yield B83 bombs. However in 1987, the DoD announced that it was curtailing B53 retirement and bringing retired (and still assembled) bombs back into active inventory. The bomb was apparently being reactivated to retain a high-yield weapon for use against deeply buried targets such as command centres until a new penetrating warhead bomb became available. However, it was reported in 1995 that all B53 bombs had been taken out of service.

Specifications
Length: 3.76 m
Body diameter: 1.03 m
Tailspan: 1.80 m
Lug Spacing: n/k
Weight: 4,022 kg
Yield: 9MT
Accuracy: n/k

Contractor
Not known.

V-1000

Type
Medium-range, ground-based, liquid propellant, single warhead, theatre defence missile.

Development
A surface-to-air missile 'Griffon' was first seen on parade in Moscow in 1963, and was mistakenly thought to be an anti-ballistic missile by some reporters. The Russian designator for 'Griffon' was 5V11 and it was called Dal. This was a two-stage SAM, designed to intercept high-flying aircraft, and entered service in 1960. The first attempted Russian anti-ballistic missile was the V-1000. which was designed by the Grushin OKB. V-1000 had a different boost motor assembly to the 'Griffon' design, with three large clipped-tip delta fins. Test launches for the V-1000 started in 1956, but the missile did not enter operational service. The V-1000 was replaced by the SH-01 'Galosh' for anti-ballistic missile defence.

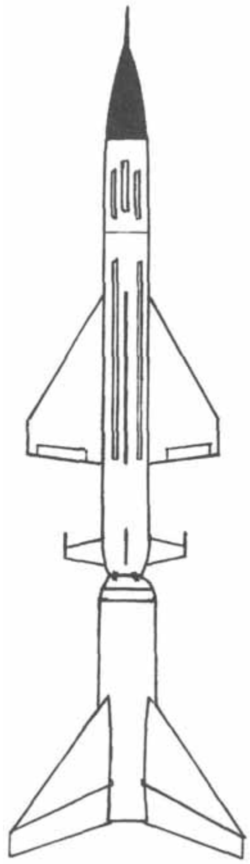
Description
The two-stage V-1000 missile was similar in appearance, but much larger, than SA-2 'Guideline'. The missile was 17.0 m long, had a body diameter of 1.3 m for the boost motor and 0.8 m for the second stage. The liquid propellant second stage had four clipped-tip delta wings with ailerons, and with a span of 3.7 m. There were four moving rectangular control fins at the rear, fitted with command guidance radio antenna at the tips. The solid propellant boost motor assembly had three clipped-tip delta wings with a span of 5.3 m, and was mounted in tandem but jettisoned after use. V-1000 had a launch weight of around 10,000 kg and was fitted with an HE blast fragmentation warhead. Guidance was by command link, by radio transmissions from the ground control station. The ground control station had a M-40 computer to calculate the intercept geometry and guidance commands. A surveillance radar, RE-I, with a 15 m long antenna was developed, together with two engagement radars, RE-2/-3. A sector scan radar, Dunai 2, was added during the development programme. The maximum intercept altitude was 30 km, and the maximum range 300 km. It is reported that the missiles were stored in bunkers and moved to their launch sites on large rail launcher assemblies. The missiles were mounted on a single tower launcher platform, which could rotate through 360°, with the launcher beam and missile raised in elevation to about 75" before firing.

A 'Griffon' SAM on display in Moscow in 1963. The V-1000 was similar, but had a larger boost motor assembly with three larger clipped-tip delta fins

Operational status
There was considerable confusion at the time between the 'Griffon' SAM and the V-1000 missiles. Some 30 'Griffon' launchers were seen deployed around Leningrad in 1960, but these had all been dismantled by 1964. Flight tests of V-1000 started in 1956, and the radars were tested from 1957. Flight tests were made against R-5 (SS-3 'Shyster') and R-12 (SS-4 'Sandel') missiles, and the first successful intercept of an IRBM was made with a V-1000 in March 1961 at an altitude of 25 km. It is reported that the V-1000 did not enter service, probably because it required several radars to complete a successful intercept, the missile was too slow, and the system was not accurate enough.

Specifications
Length: 17.0 m
Body diameter:
1.3 m (1st stage)
0.8 m (2nd stage)
Launch weight: 10,000 kg
Warhead: HE
Guidance: Command
Propulsion: Liquid with solid boost stage
Range: 300 km

Contractor
The V-1000 system was designed by the Grushin OKB.



A line diagram of the V-1000 missile

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SH-01 'Galosh' (A350Zh)

Type

Medium-range, ground-based, liquid propellant, anti-ballistic missile.

Development

The SH-01 'Galosh' was the initial ground-based version of the medium-range component of the Moscow anti-ballistic missile system. The former Soviet Union set out to deploy an ABM system around its national capital, Moscow, in 1953 and the Russian designator for the complete system was A-35, with the West designating the system ABM-I. The missile was given the Russian designator A350Zh, and the West gave the missile the name SH-01 'Galosh' or ABM-I b. A test site was developed at Sary-Shagan from 1956, and a target area in Kazakhstan was constructed with three radars (probably using an interferometer system) located 85 km around the target. The radars were used to accurately track the incoming missiles and the intercepting anti-ballistic missiles, to generate guidance commands for the interceptors. A test was conducted in 1961, when a trials SH-01 interceptor hit an incoming SS-4 'Sandel' warhead travelling in excess of 3 km/s. The ground radars tracked the incoming target from 1,500 km, and a trials SH-01 with a HE warhead destroyed the re-entry vehicle from the SS-4 target. There were experiments with an IR seeker in the SH-01 nose section, for terminal guidance, but these were not successful. The ABM-I system was improved during the 1970s to include nuclear hardening of all the facilities, but the interceptor modernisation programme began in 1980 when the SH-11 'Gorgon', an updated solid propellant silo-based ABM, was introduced to replace SH-01.

Description

The SH-01 'Galosh' missile was a contemporary of the SS-11 ICBM, with which it may have had some component commonality. 'Galosh' was displayed in its transport canister, with its first appearance at the 1974 Moscow parade, which revealed its four first-stage rocket nozzles. The SH-01 'Galosh' was a two-stage, solid and liquid propelled, medium-range missile, 19.8 m long and 2.57 m in diameter. Its intercept range was believed to be about 350 km, and launch weight about 33,000 kg. The first stage consisted of four wraparound solid propellant boost motors, similar to the configuration adopted for the SA-5 'Gammon' surface-to-air missile, which were jettisoned after use. The second stage had a 2.0 m diameter liquid propellant motor, believed to be similar to the second-stage motor of the UR-100 ballistic missile (SS-11 'Sego'), and four large clipped-tip delta control fins at the rear. The missile had a single nuclear warhead and was command guided from the ground. The provision of six dual mode surveillance and engagement radars at each 'Galosh' site implied a capability to manage several interceptions at once, and it is believed that the ABM-I system was designed to handle a raid of six to eight ballistic missiles on Moscow. Towards the end of its operational life the original radars were being replaced by four phased-array radars as part of the ABM system modernisation programme, and it is assumed that these were for use with SH-11 'Gorgon'.

SH-01 Galosh anti-ballistic missile seen on parade in Moscow 0132983

Operational status

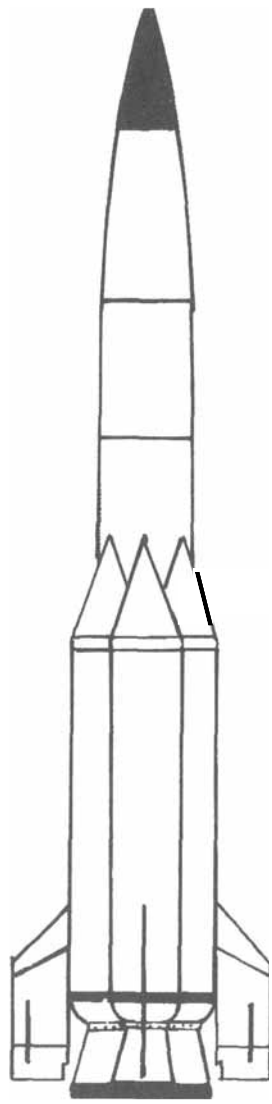
The SH-01 'Galosh' started to be deployed in 1968, but did not become operational until 1971 as the original ABM system around Moscow. This ABM system comprised 64 SH-01 'Galosh' missiles on re-loadable above ground launchers located at four sites to the north and west of the city; at Klin, Novo-Petrovskoye, Verena and Aleksandrov. It is believed that there were about 80 further reload missiles available at the four sites. The system control centre was located at Kubinka, 70 km from central Moscow, close to the large 'Dog House' radar used for early warning. Further test flights were made throughout the 1970s. with reported tests in 1972 and 1974. The number of SH-01 fell to 16 during the early stages of the ABM upgrade programme which started in 1980, and by 1988 the SH-01 had been completely replaced by the SH-11 'Gorgon'.

Specifications

Length: 19.8 m
Body diameter: 2.57 m
Launch weight: 33,000 kg
Warhead: Single 1 MT nuclear
Guidance: Command
Propulsion: Liquid propellant with solid boosters
Range: 350 km

Contractor

The ABM-I system is reported to have been designed by a team led by G V Kisunko and P D Grouchine, with the SH-01 'Galosh' missile designed by the Grushin OKB and manufactured by Fakel NPO.



A line diagram of a SH-01 missile 2002

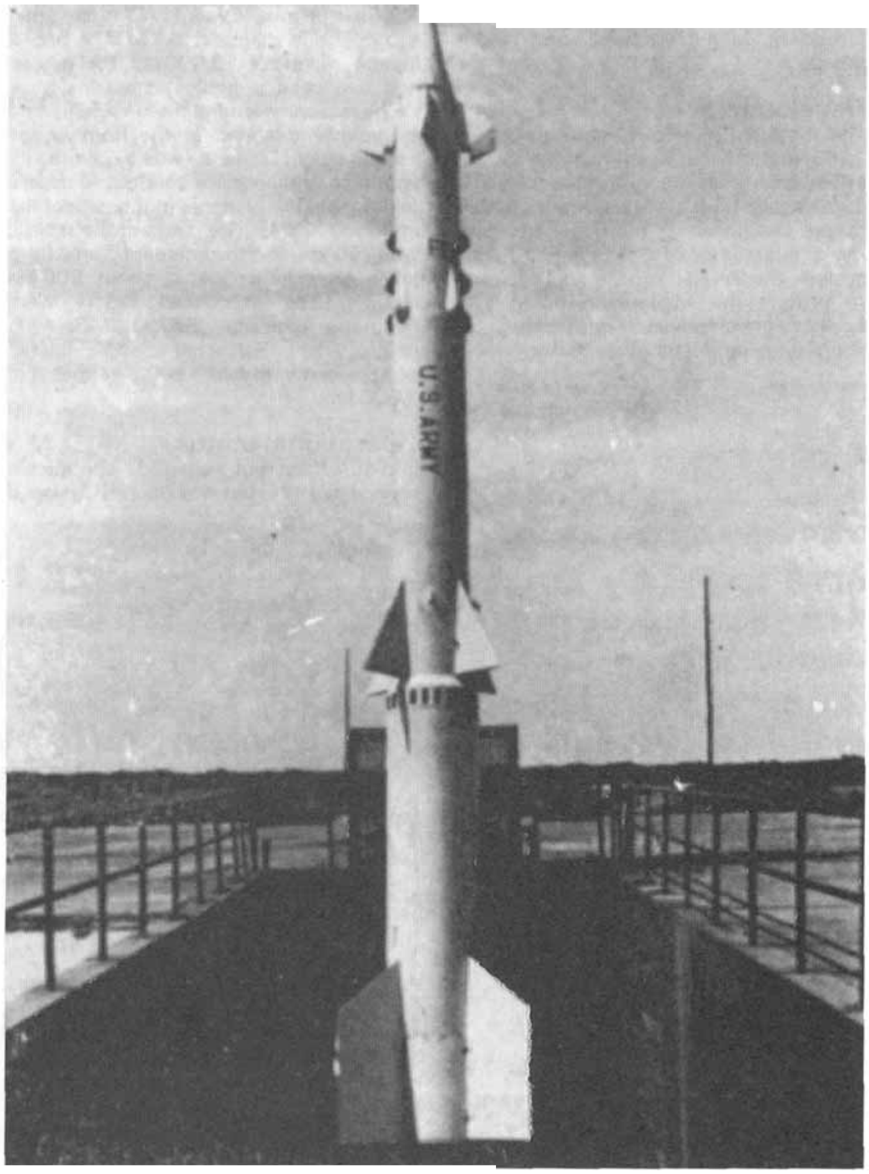
Nike Zeus

Type
Medium-range, ground-based, solid propellant, single warhead, anti-ballistic missile.

Development
The Nike Zeus programme was started by the US Army in 1957, with the intention of forming part of the Nike **X** (later 'Sentinel') Anti-Ballistic Missile (ABM) system, Nike Zeus was based on the Nike-Ajax and Nike-Hercules SAM designs, and the first trial launch was made in 1959. The first intercept was achieved in 1962, against a target launched by an Atlas ICBM from 7,000 km away. An ASAT version of Nike Zeus was deployed at Kwajalein in the Pacific in 1964 for use against low earth orbit satellites, but this was replaced in 1966 by the Thor ASAT.

Description
The missile was 14.73 m long, had a body diameter of 0.91 m and a launch weight of 10,350 kg. The first boost stage had a solid propellant motor and four clipped delta wings, and was jettisoned after burning. The second stage had a solid propellant sustainer motor and included a W-31 nuclear warhead in a kill vehicle rated at about 20 kT. Nike Zeus was command guided and the warhead detonated by command. There were four associated radars: the Zeus acquisition radar; the discrimination radar (to identify the incoming re-entry vehicles); the target track radars; and the Zeus missile track radars. As the radars were mechanical turning systems, each radar could only track one target and one missile at a time. The missile range was 250 km.

Operational status
Nike Zeus entered service in 1965, and the system was replaced by the Safeguard ABM system in 1975. A proposal to add the Sprint missile as an underlay to Nike Zeus, to be known as the Sentinel ABM system. was terminated in 1969 in favour of developing Saartan as the upper tier for the Safeguard system.



A trial Nike Zeus ABM on its launch pad

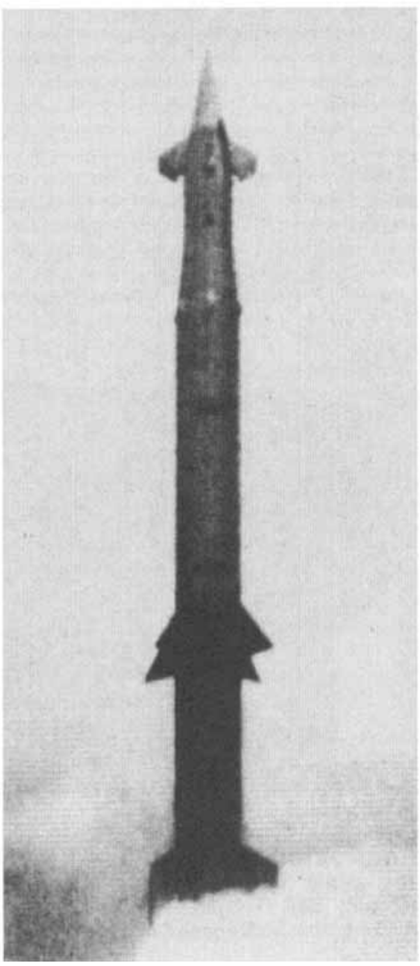
Specifications
Length: 14.73 m
Body diameter: 0.91 m
Launch weight: 10,350 kg
Warhead: 20 kT nuclear
Guidance: Command
Propulsion: Solid propellant
Range: 250 km

Contractors
The prime contractors were Western Electric, Bell Telephone and Douglas Aircraft (now McDonnell Douglas).

LIM-49A Spartan

Type
Long-range, ground-based, solid propellant, single warhead, anti-ballistic missile.

Development
The Spartan missile design started in 1965, and the first flight trials were made in 1968. The first intercept was achieved in 1970 against a trials Minuteman I missile target. Developed as the upper tier long-range interceptor of the Safeguard ABM system, the Spartan missile was designed to protect the Minuteman ICBM silos against a pre-emptive attack. The lower tier short-range interceptor was Sprint.



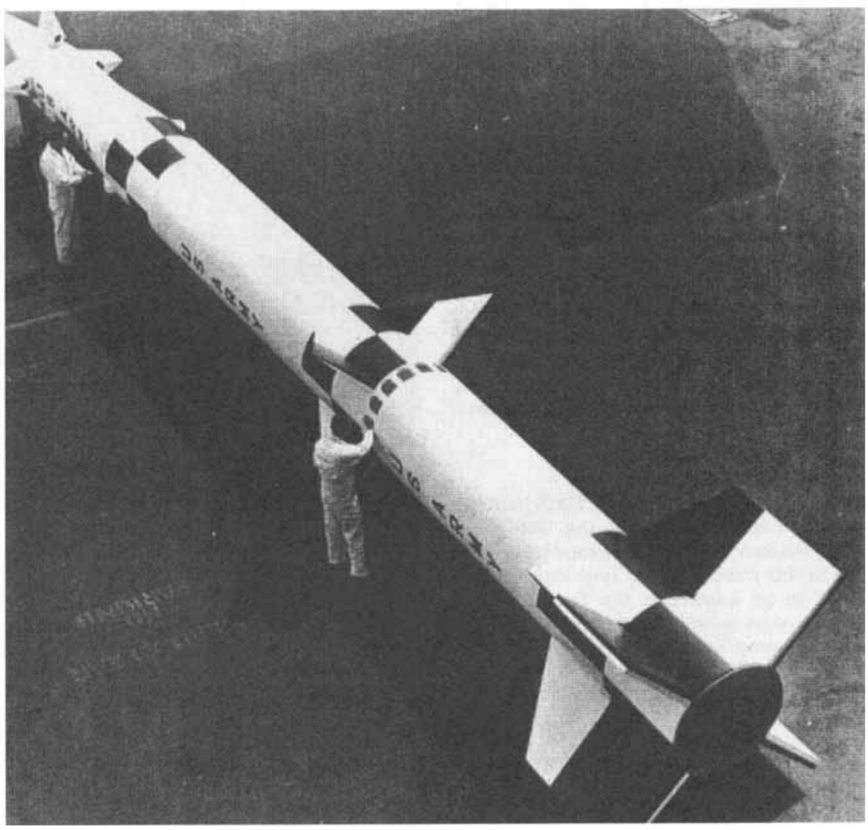
*Trials launch of a **Spartan ABM***

Description
The Spartan missile was 16.83 rn long, had a base body diameter of 107 m and a launch weight of 13,000 kg. The missile had two solid propellant stages, with a W-71 nuclear warhead rated at 5 MT in a kill vehicle mounted at the front of the second stage. Guidance was by command, with a command pulse sent to the missile to detonate the warhead in the path of the attacking ICBMs. The range of the missile was 750 km, and the intercept would have taken place in space at about 500 km altitude. The associated radars were Perimeter Acquisition Radars (PARs) with ranges of 3,000 km and missile engagement radars with ranges of 1,000 km.

Operational status
LIM-49A Spartan entered operational service in 1975, but was decommissioned in 1976 It is believed that the missiles were stored until they were scrapped in 1983. There were 30 Spartan missiles located in underground silos at the Grand Forks site.

Specifications
Length: 16.83 m
Body diameter: 1.07 m
Launch weight: 13,000 kg
Warhead: 5 MT nuclear
Guidance: Command
Propulsion: Solid propellant
Range: 750 km

Contractors
The prime contractors were Western Electric and McDonnell Douglas, with the radars produced by General Electric and Raytheon.



A full-scale model of a Spartan ABM

Sprint

Type
Short-range, ground-based, solid propellant, single warhead, anti-ballistic missile.

Development
Originally developed to be the short-range lower tier interceptor for the Nike **X** (later Sentinel) ABM system, Sprint became the lower tier of the Safeguard system as the Sentinel system was cancelled in 1969. Design of Sprint started in 1963 and the first trials launch took place in 1965. The first intercept was made in 1970 against a trials Minuteman I ICBM target, and a total of 48 test firings were made between 1970 and 1974.

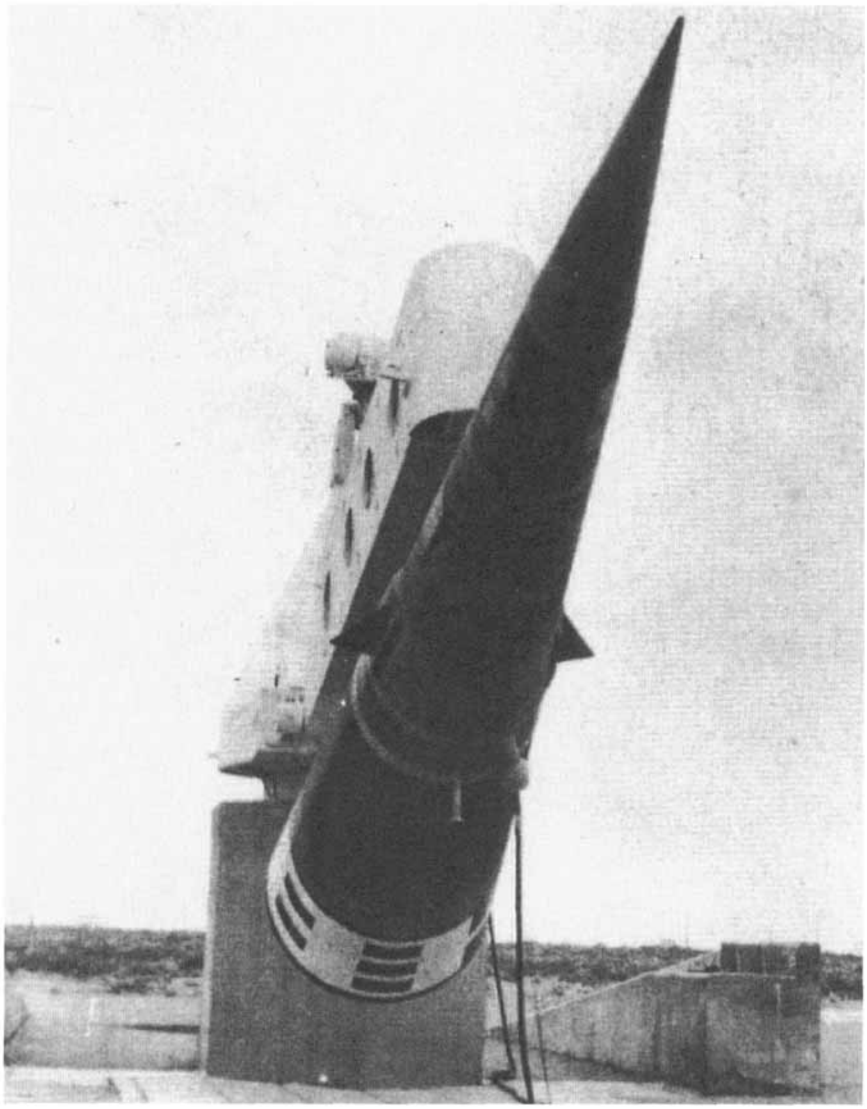
Description
Sprint was a cone shaped two-stage solid propellant ABM, 8.20 m long, with a base body diameter of 1.40 m and a launch weight of 3,400 kg. The missile was cold launched from an underground silo using a gas generator and piston assembly to push the missile out of the silo before the first stage motor ignited. The first stage motor used a fluid injection nozzle control system, whilst the second stage had four rear-mounted control fins. Sprint was command guided, and the W-66 nuclear warhead rated at 10 kT was command initiated in the path of the incoming re-entry vehicle. The missile had a range of 40 km, and the intercept would probably have taken place at between 25,000 and 35,000 m (82,000 and 114,800 ft) altitude. A missile site radar was used to track the incoming target and the Sprint missile.

A Sprint short-range ABM shortly after launch

Operational status
The Sprint missile entered operational service in 1975, but was decommissioned in 1976. It is believed that the missiles were stored until they were scrapped in 1983. There were 70 Sprint missiles located in underground silos at the Grand Forks, North Dakota site.

Specifications
Length: 8.20 m
Body diameter: 1.40 m
Launch weight: 3,400 kg
Warhead: 10 kT nuclear
Guidance: Command
Propulsion: Solid propellant
Range: 40 krn

Contractor
The prime contractor was Martin Marietta (now Lockheed Martin).



Early trials Sprint missile on launcher rail at White Sands Missile Range

PRIME CONTRACTORS' ADDRESSES

Prime Contractors Addresses

ARGENTINA

Fabrica Argentina de Material Aerospatiale (FAMA)
Avda Fuerza Aerea Argentina, km 5%
Guarnicion
5103 Cordoba
Tel: (+54 51) 205 43
Entries: Alacran (Offensive Weapons)

BRAZIL

Avibras Industria Aeroespacial SA
Antiga Estrada de Paraibuna, km 118
PO Box 229
12201-970 São Jose dos Campos (SP)
Tel: (+55 123) 21 74 33
Entries: TM Astros, (Offensive Weapons); FOG-MPM (Defensive Weapons)

CANADA

Oerlikon Contraves Defence
Rheinmetall DeTec AG
225 Boulevard du Seminaire Sud
Saint-Jean-sur-Richelieu
Quebec J3B 8E9
Tel: (+1 514) 358 20 00
Entries: ADATS (Defensive Weapons)

CHINA, PEOPLE's REPUBLIC

China Aerospace Industry Corporation (CAIC)
PO Box 848
8, Fucheng Road
Beijing 100830
Tel: (+86 10) 837 08 11
Entries: CSS-2, CSS-3, CSS-4, CSS-5, CSS-6, DF-31, DF-41, DF-25, JL-1, JL-2 (Offensive Weapons)

China National Aero-Technology Import and Export Corporation (CATIC)
5 Lianqguochang Road
East City District
PO Box 647
Beijing
Tel: (+86 1) 44 58 31
Entries: CSS-N-1 Mod 2 (FL-I), FL-2, FL-7, FL-10 (Offensive Weapons)

China National Precision Machinery Import and Export Corporation (CPMIEC)
PO Box 129
22 Fu Cheny Road
100036 Beijing
Tel: (+86 1) 842 91 26
Entries: CSS-6 (M-9), CSS-7 (M-11), CSS-8 (M-7), CSSC-2 (HY-I), CSSCS (HY-2), CSSC-5 (YJ-16/C-101), CSS-N-4 (YJ-1/C-801), CSSCS (YJ-2/C-802), CSS-N-1 (SY-1), CSS-N-2 (HY-1), CSSC-7 (HY-4/C-201), CAS-1 (C-601/C-611), HN-1/2/3, CF-2000 (Offensive Weapons); HQ-2, CSA-N-2, FM-80, FM-90, FT-2000, KS-1, LY-60 (Defensive Weapons)

Nanchang Aircraft Manufacturing Co
PO Box 5001
Nanchang
Jiangxi 330024
Tel: (+86 791) 251 833
Entries: CSS-N-1 Mod 2 (FL-I), FL-2, FL-7, FL-10 (Offensive Weapons)

FRANCE

EADS Launch Vehicles
66, rte de Verneuil
PO Box 3002
F-78133 Les Mureaux Cedex
Tel: (+33 5) 34 75 01 23
Entries: M-4, M-45, M-51 (Offensive Weapons); Latex (Defensive Weapons)

MBDA Missile Systems (EADS)
2 rue Béranger
F-92322 Chatillon-sous-Bagneux Cedex
Tel: (+33 2) 47 46 21 21
Entries: ASMP, ASMP-A, MM 38, AM 39, SM 39, MM 40 Exocet, ANF (Offensive Weapons); FSAF Aster (Defensive Weapons)

MBDA Missile Systems
20-22, rue Grange Dame Rose
BP 150
F-78141 Velizy-Villacoublay cedex
Tel: (+33 1) 34 88 20 03
Entries: ASMP, ASMP-A, MM 38, MM 39, AM 39, MM 40 Exocet, ANF, Polyphem/TRIFOM/Triton, Otomat, Milas, APACHE (Offensive Weapons); Crotale, RM5 Roland, Aster 15/30, Polyphem/TRIFOM/Triton (Defensive Weapons)

Thales Airsystems
1 rue des Mathurins
PO Box 10
F-78140 Bagneux Cedex
Tel: (+33 2) 40 84 40 00
Entries: AS 34 Kormoran (Offensive Weapons); Aster 15/30, Crotale (Defensive Weapons)

GERMANY

LFK – Lenkflugkorpersysteme GmbH (part of EADS)
PO Box 80 11 49
D-81663 Munich
Tel: (+49 89) 60 72 64 81
Entries: AS 34 Kormoran, Polyphem/TRIFOM/Triton, KEPD-150/350 Taurus (Offensive Weapons); Ground-Based Laser, Roland, TLVS/MEADS (Defensive Weapons)

RAM Systems GmbH
Daimlerstrasse, 11
D-85521 Ottobrunn/Munich
Tel: (+49 89) 60 80 03 43
Entries: RIM-I 16 RAM (Defensive Weapons)

INDIA

Bharat Dynamics Ltd
Kanchanbagh
Hyderabad 500 258
Tel: (+9 1 40) 23 94 64
Entries: Agni SR,1/2/3, Prithvi 150/250, Dhanush (Offensive Weapons); Akash (Defensive Weapons)

Defence Research and Development Laboratories
Hyderabad
Tel: (+9 1 40) 490 21
Entries: Agni SR,1/2/3, PJ-10 Brahmos, Sagarika (Offensive Weapons), Akash, Trishul (Defensive Weapons)

IRAN

Hermat Missile Industries
Tehran
Entries: Scud B variant, Scud C variant, Shahab 3, Shahab 4 (Offensive Weapons)

Iranian Defence Organisation
PO Box 13185
143 Tehran
Tel: (+98 21) 84 28 59
Entries: Nazeat, Zelzal 2 (Offensive Weapons)

IRAQ

Military Production Authority
PO Box 5757
Baghdad
Entries: FAW 70/150/200, Al Hussein, Al Samoud, Sakr/Ababil (Offensive Weapons)

ISRAEL

Israel Aircraft Industries
Ben Gurion International Airport
11-70100 Tel Aviv
Tel: (+972 3) 97 12 48 or 971 31 10
Entries: Jericho 1/2/3 (Offensive Weapons)

Israel Aircraft Industries
Electronics Division
PO Box 105
IL-5600 Yahud Industrial Zone
Tel: (+972 3) 536 39 75
Entries: Gabriel (Offensive Weapons); Barak, Arrow, Derby (Defensive Weapons)

Rafael Armament Development
PO Box 2250
IL-31021 Haifa
Tel: (+972 4) 77 69 65
Entries: AGM-142 Popeye (Offensive Weapons); Barak, Derby (Defensive Weapons)

ITALY

MBDA Missile Systems
Via Tiburtina km 12,400
PO Box 7083
1-00131 Rome
Tel: (+39 6) 41 97 35 19
Entries: Otomat, Teseo 3, Milas, Sea Killer 2, Marte 2 Polyphem/TRIFOM/Triton (Offensive Weapons); Aspide, Aster 15/30 (Defensive Weapons)

JAPAN

Mitsubishi Heavy Industries
Nagoya Guidance and Propulsion Systems
1200 Higashitanaka
Komaki City
Aichi-kan 485-8561
Tel: (+81 568) 79 21 13
Entries: SSM-1A (type 88), SSM-1B (type 90/96), ASM-1 (type 80/91), ASM-2 (type 93/96), ASM-3, SSM-2 (Offensive Weapons)

Toshiba Electronic Systems
Akasaka 2-chome
Minato-ku
Tokyo 107
Tel: (+81 3) 582 29 51
Entries: Tan-SAM 1 (type 81). Tan-SAM 2 (Defensive Weapons)

KAZAKHSTAN

Petropavlovsk Machinery Plant
Petropavlovsk
Kazakhstan
Entries: SS-21 (Offensive Weapons)

KOREA, NORTH

Fourth Machine Industry Bureau
Pyongyang
Entries: Scud B variant, Scud C variant, Scud D variant, No-dong 1/2, Taep'o-dong 1, Taep'o-dong 2 (Offensive Weapons)

KOREA, SOUTH

Daewoo Heavy Industries
6, Manseong-dong
Dong-gu
PO Box 7955
Inchon 401-702
Tel: (+82 32) 760 11 14
Entries: Chun-Ma (Defensive Weapons)

NORWAY

Kongsberg Defence and Aerospace (KDA)
PO Box 1003
N-3601 Kongsberg
Tel: (+47 3) 273 82 00
Entries: AGM-119 Penguin 1/2/3, NSM (Offensive Weapons); MIM-120 NASAMS (Defensive Weapons)

PAKISTAN

Khan Research Laboratories Karhuta
PO Box 502
Rawalpindi
Tel: (+51 92) 80133
Entries: Hatf 5 (Ghauri 1), Hatf 5A (Ghauri 2) (Offensive Weapons)

National Development Complex
PO Box 2216
Islamabad
Tel: (+92 051) 28 23 15
Entries: Hatf 1, Hatf 2 (Abdali), Hatf 3 (Ghaznavi), Hatf 4 (Shaheen 1), Hatf 6 (Shaheen 2) (Offensive Weapons)

RUSSIAN FEDERATION

Almaz NPO
80 Leningradsky Pr
125178 Moscow
Tel: (+7 095) 158 26 20
Entries: SA-2, SA-3, SA-5, SA-10, MRADS (Defensive Weapons)

Altair NPO
57 Aviamotornaya Str
111024 Moscow
Tel: (+7 095) 273 1432
Entries: SS-N-14, SS-N-22 (Offensive Weapons); SA-N-1, SA-N-3, SA-N-6, SA-N-7, SA-N-9, SA-N-11, SA-N-12 (Defensive Weapons)

Antey NPO
41 Vereyskaya Str
121471 Moscow
Tel: (+7 095) 448 75 32
Entries: SA-4, SA-8, SA-12, SA-15, SA-N-4, SA-N-9 (Defensive Weapons)

Defence Systems
29, Vereiskaya Str
Moscow 121357
Tel: (+7 095) 440 09 12
Entries: Trieumf (S-400) (Defensive Weapons)

Dolgoprudny Research and Production Enterprise
1, Sobin Street
Dolgoprudny 141700
Moscow Region
Tel: (+7 095) 408 34 22
Entries: SA-11, SA-17, SA-N-7, SA-N-12 (Defensive Weapons)

Fakel MKB
Academician Grushin Street, 33
Khimky
141400 Moscow
Tel: (+7 095) 572 51 00
Entries: SA-2, SA-3, SA-5, SA-8, SA-10, SA-15, SA-N-1, SA-N-3, SA-N-4, SA-N-6, SA-N-9, SH-11 (Defensive Weapons)

Gravit
7 Molodogvardeyskaya Str
Moscow
Tel: (+7 095) 144 77 96
Entries: SA-6, SA-10, SA-11, SA-17 (Defensive Weapons)

KBM Engineering Design Bureau
42 Oksky Prospect
140402 Kolomna
Moscow Region
Tel: (+7 096) 613 30 64
Entries: SS-21, SS-X-26, SS-N-3, SS-N-9, SS-N-12, SS-N-19 (Offensive Weapons), SA-19, SA-N-11 (Defensive Weapons)

KBP Instrument Design Bureau
Shcheglovskaya Zaseka Str
300001 Tula
Tel: (+7 0872) 41 07 50
Entries: SA-19, SA-N-11, Pantsir-SI (Defensive Weapons)

Mashinostroenia NPO (Engineering Research and Production Association)
33 Gagarin St
Reutov
Moscow Region 143952
Tel: (+7 095) 302 1185
Entries: SS-19, SS-N-26/SSC-5, PJ-10 Brahmos (Offensive Weapons)

Moscow Institute of Heat Technology
10/1 Beryozovaya Alleya
Moscow 127276
Tel: (+7 095) 402 60 9
Entries: SS-25, SS-27, SS-N-29 (Medvedka) (Offensive Weapons)

NIIIP Measuring Instruments Research Bureau
Gorky Street, 76
630099 Novosibirsk
Tel: (+7 383) 216 21 57
Entries: SA-10, SA-11, SA-12, SA-17 (Defensive Weapons)

NIIP (Tikhomirov Research Institute for Instrument Engineering)
Gagarin Str 3
Zhukovsky
140160 Moscow
Tel: (+7 095) 556 23 48
Entries: SA-6, SA-11, SA-17, SA-N-7, SA-N-12 (Defensive Weapons)

Novator Experimental Machine Design Bureau
Prospekt Kosmonavtov, 18
620017 Ekaterinburg
Tel: (+7 0343) 239 55 60
Entries: SS-N-15, SS-N-16, SS-N-21, SS-NX-27, 91R1, 91R2 (Offensive Weapons); SA-4, SA-11, SA-12, SH-08 (Defensive Weapons)

Raduga NPO
2a, Zhukovsky Str
Dubna
141980 Moscow Region
Tel: (+7 096) 212 46 47
Entries: SS-N-2, SS-N-14, SS-N-22, SSC-3. AS-4, AS-6, AS-13. AS-15, AS-16, AS-18, Kh-32, Kh-38, Kh-41, Kh-101/102 (Offensive Weapons)

Rosoboronexport
21, Gogolevsky Blvd
119992 Moscow
Tel: (+7 095) 202 66 03
Entries: All Russian weapon systems. (This Federal State Unitary Enterprise took over the defence export/import functions of several earlier Russian organisations, from January 1994. The name was changed to Rosoboronexport in 2000, following a reorganisation.)

Soyuz NPO
6 Sovetskaya st
Dzerzhisky
Moscow Region 140056
Tel: (+7 095) 551 76 23
Entries: Frog, SS-21, SS-25, SS-27 (Offensive Weapons)

Votkinsky Zavod
2 Kirov St
Votkinsk
Udmert Republic 427410
Tel: (+7 034) 145 65 251
Entries: SS-1, SS-23, SS-25, SS-27 (Offensive Weapons)

Vympel Interstate Joint Stock Corporation
3/4, Vosmogo Marta Street
125319 Moscow
Tel: (+7 095) 152 9595
Entries: SH-08, SH-11 (Defensive Weapons)

Vympel State Machine Building Design Bureau
Volokolamskoje sh, 90
123424 Moscow
Tel: (+7 095) 491 04 64
Entries: SA-6, SA-11, SA-17, SA-N-7, SA-N-12, R-77 (Defensive Weapons)

Zvezda Strela State Research and Production Centre
Ilyicha St, 7
141070 Korolev
Moscow Region
Tel: (+7 095) 519 20 02
Entries: AS-17, AS-20, SS-N-25, SSC-6 (Offensive Weapons)

SOUTH AFRICA

Denel
Kentron Division
PO Box 7412
0046 Centurion
Tel: (+27 12) 671 12 39
Entries: Raptor-1/2, MUPSOW, Torgos (Offensive Weapons) SAHV, Umkhonto (Defensive Weapons)

SWEDEN

Saab Bofors Dynamics AB
SE-691 80 Karlskoga
Tel: (+46 586) 810 00
Entries: RBS-15, KEPD-150 (Offensive Weapons), RBS 23 (Defensive Weapons)

SWITZERLAND

Oerlikon Contraves Defence, Rheinmettal DeTec AG
Birchstrasse, 155
CH-8050 Zurich
Tel: (+41 1) 316 22 11
Entries: ADATS (Defensive Weapons)

TAIWAN

Chung Shan Institute of Science and Technology
PO Box 90008-1
Lung-Tan
Tao-Yuan
Tel: (+886 3) 471 22 01
Entries: Hsiung Feng 1/2/3 (Offensive Weapons); Sky Bow 1/2, Tien Chien 2 (Defensive Weapons)

UKRAINE

Yuzhnoye NPO
Krivorozhskaya Str 3
Dnepropetrovsk
320059 Ukraine
Tel: (+380 56) 242 20 21
Entries: SS-18, SS-24 (Offensive Weapons)

UNITED KINGDOM

MBDA Missile Systems
11, Strand
London WC2N 5RI
Tel: (+44 207) 451 60 00
Entries: Sea Eagle, PGM-500/-2000 (Offensive Weapons); Rapier 2000, Sea Dart, Seawolf (Defensive Weapons)

UNITED STATES OF AMERICA

Boeing Integrated Defense Systems
PO Box 516
St Louis
Missouri 63166-0516
Tel: (+1 314) 232 02 32
Entries: RGM/UGM-109 Tomahawk, AGM-86 ALCM/CALCM, AGM-129 ACM, AGM/RGM/UGM-84 Harpoon, SLAM, SLAM-ER, Sea SLAM, AGM-130, ARRMD (Offensive Weapons) MIM-14 Nike Hercules (Defensive Weapons)

Boeing Integrated Defense Systems
2201, Seal Beach Boulevard
Seal Beach
California 90740
Tel: (+1 562) 797 10 22
Entries: LGM-30F Minuteman III, LGM-118 Peacekeeper (Offensive Weapons); ASM-135 ASAT, Airborne Laser, GMD, Ground-Based Laser, PAC-3 (Defensive Weapons)

Lawrence Livermore National Laboratory
PO Box 808
Livermore
California 94551
Tel: (+1 415) 422 11 00
Entries: B 83 (Offensive Weapons), Ground-Based Laser (Defensive Weapons)

Lockheed Martin Space Systems
PO Box 179
Denver
Colorado 80201
Tel: (+1 303) 977 30 00
Entries: LGM-118 Peacekeeper, (Offensive Weapons); Space-Based Laser, (Defensive Weapons)

Lockheed Martin Systems Integration
Missile and Fire Control
PO Box 5837
Sand Lake Road
Orlando
Florida 32855
Tel: (+1 407) 356 20 00
Entries: AGM-158 (Offensive Weapons) ADATS, MIM-104 Patriot (Defensive Weapons)

Lockheed Martin Systems Integration
Missile and Fire Control
PO Box 650003
Dallas
Texas 75265-0003
Tel: (+1 972) 603 10 00
Entries: MGM-52 Lance, MGM-140 ATACMS, GMLRS (Offensive Weapons); ASM-135 ASAT and PAC-3 (Defensive Weapons)

Lockheed Martin Space Systems
PO Box 3504
1111 Lockheed Way
Sunnyvale
California 94088-3504
Tel: (+1 408) 742 66 88
Entries: UGM-96 Trident C-4, UGM-133 Trident D-5 (Offensive Weapons); GMD, THAAD, ABL (Defensive Weapons)

Lockheed Martin Systems Integration
Naval Electronics and Surveillance Systems
1210 Massillon Road
Akron
Ohio 44315
Tel: (+1 303) 796 21 21
Entries: RUR-5 ASROC, RUM-I39 VL-ASROC (Offensive Weapons)

Los Alamos National Laboratory
PO Box 1663
Los Alamos
New Mexico 87544
Tel: (+1 505) 667 39 05
Entries: B 57, B 61 (Offensive Weapons), Ground-Based Laser (Defensive Weapons)

Northrop Grumman Corporation
2301 West 120th Street
Hawthorne
California 90251-5032
Tel: (+1 213) 600 40 28
Entries: MGM-140 (BAT) (Offensive Weapons); MALI (Defensive Weapons)

Precision Guided Systems United States
5600, Sand Lake Road
Orlando
Florida
Tel: (+1 407) 356 20 00
Entries: AGM-142 (Offensive Weapons)

Raytheon Missile Systems
PO Box 11337
Tucson
Arizona 85734
Tel: (+1 520) 794 82 41
Entries: RGM/UGM-109 Tomahawk, AGM-129 ACM, (Offensive Weapons) RIM-I 16 RAM, MIM-120 NASAMS, THAAD, MIM-23 HAWK, MIM-104 Patriot, RIM-7 Sea Sparrow, RIM-I62 ESSM, RIM-66/67/156 Standard, GMD, SM-3, EFOG-M (Defensive Weapons)

TRW Space and Technology Group
1 Space Park
Redondo Beach
California 90278-1001
Tel: (+1 310) 812 23 13
Entries: Ground-Based Laser (THEL), Space-Based Laser (Defensive Weapons)

TRW Strategic Systems Division
PO Box 1310
San Bernardino
California 92402-1310
Tel: (+1 909) 382 62 34
Entries: LGM-30F Minuteman III (Offensive Weapons)

ALPHABETICAL INDEX

Alphabetical index

Europe, Middle East and Africa
Jane's Information Group
Sentinel House
163 Brighton Road
Coulsdon, Surrey CR5 2YH
United Kingdom
Tel: (+44 (0) 20) 8700 3700
Fax: (+44 (0) 20) 8763 1006
e-mail: info@janes.co.uk

North/Central/South America
Jane's Information Group
110 N. Royal Street
Suite 200
Alexandria, VA 22314
United States
Tel: (+1 703) 683 3700
(+1 800) 824 0768
Fax: (+1 703) 836 0297
(+1 800) 836 0297
e-mail: info@janes.com

Asia
Jane's Information Group
5 Shenton Way
#01-01, UIC Building
Singapore 068808
Tel: (+65) 6410 1240
Fax: (+65) 6226 1185
e-mail: info@janes.com.sg

London
Jane's Information Group
The Quadrangle
180 Wardour Street, 1st Floor
London W1F 8FY
United Kingdom
Tel: (+44 (0) 20) 8700 3700
Fax: (+44 (0) 20) 8763 1006
e-mail: info@janes.co.uk

USA West Coast
Jane's Information Group
201 East Sandpointe Avenue
Suite 370
Santa Ana, California 92707
United States
Tel: (+1 714) 850 0585
Fax: (+1 714) 850 0606
e-mail: janeswest@janes.com

Japan
Jane's Information Group
Palaceside Building, 5F
1-1-1, Hitotsubashi
Chiyoda-ku, Tokyo 100-0003
Japan
Tel: (+81 3) 5218 7682
Fax: (+81 3) 5222 1280
e-mail: norihisa.fukuyama@janes.jp

India
Jane's Information Group
Post Box No.3806
New Delhi 110049
India
Tel: (+91 11) 2651 6105
Fax: (+91 11) 2651 6105
e-mail: janesindia@sify.com

Canada
Jane's Information Group
220 Laurier Avenue West
Suite 550
Ottawa, Ontario K1P 5Z9
Canada
Tel: (+1 613) 288 0189
Fax: (+1 613) 288 0190
e-mail: geoff.mizen@janes.com

Australia and New Zealand
Jane's Information Group
PO Box 3502
Rozelle Delivery Centre
New South Wales 2039
Australia
Tel: (+61 2) 8587 7900
Fax: (+61 2) 8587 7901
e-mail: janesinfo@janes.thomson.com.au